AKADEMIYA NAUK SSSR. BOTANICHESKII INSTITUT IM. V. A. KOMAROVA
Academy of Sciences of the USSR. Komarov Institute of Botany

CRYPTOGAMIC PLANTS OF THE USSR

(Flora sporovykh rastenii SSSR)

Edited by V.P. Savich

Volume IV

FUNGI (1)

(Griby)

V.F. Kuprevich and V.G. Transhel'

RUST FUNGI

(Rzhavchinnye griby)

No. 1

FAMILY MELAMPSORACEAE

Izdatel'stvo Akademii Nauk SSSR
Moskva-Leningrad
1957

Translated from Russian

Israel Program for Scientific Translations
Jerusalem 1970

IPST Cat. No. 5564

Translated by Dr. E. Rabinovitz

Printed in Jerusalem by Keter Press
Binding: Wiener Bindery Ltd., Jerusalem

XII/4/3

Table of Contents

TRANSLATOR'S NOTE

The attention of the reader is drawn to alternate spellings of certain names appearing in the text and bibliographies. The names of Russian authors have been transliterated in accordance with accepted rules (British Standard), except for non-Russian publications or when constituting part of a name of species or genera, in which case their names appear in the Latinized version. A list is given below of names with variant spelling.

Transliterated name	Latinized version
Bukhgol'ts, F.	Buchholtz, F.
Ditrikh, A.	Dietrich, A.
Dovnar, N.	Downar, N.
Kuprevich, V. F.	Kuprewicz, V. P.
Kursanov, L.	Kursanow, L.
Liboshits, I.	Liboschitz, J.
Mart'yanov, N. M.	Martianoff, N. M
Minkevichus, A.	Minkevičius, A.
Naumov, N. A.	Naoumoff, N.
Regelis, K.	Regel, C.
Semashko, V.	Siemaszko, W.
Syuzev, P.	Siuzev, P.
Tannuks, K.	Tannux, K. K.
Transhel', V. G.	Tranzschel, W.
Trebu, O.	Treboux, O.
Trzhebinskii, I.	Trzebinski, J.
Yachevskii, A. A.	Jaczewski, A.

5* # PREFACE

This book describes 180 species of rust fungi of the family **Melampsoraceae**. Among them is a considerable number of species which cause harm in agriculture and forestry. The book can serve as a reference source for the identification of rust fungi and for measures to combat them.

Investigations on rust fungi were begun in 1938 by V. G. Tranzschel,[1] while his well-known "Obzor rzhavchinnykh gribov SSSR" (Conspectus Uredinalium URSS) was still being printed. The publication of this work facilitated preparation of the present book. According to the plan proposed by V. G. Tranzschel, description of the rust fungi included a sufficiently detailed description of species, references to pertinent literature, synonyms, data on biological properties, and a list of host plants with indication of their distribution according to regions corresponding to those listed in "Flora of the USSR," published by the Institute of Botany of AN SSSR [the Academy of Sciences of the USSR], or a catalog listing major locations. Unlike "Flora of the USSR," description of the species included a complete list of synonyms.

The synonyms reflect the history of the investigated fungus, its morphology, the frequency of finds, and its relation to other species; often they reflect the opinion of the investigator. This can be illustrated by the list of synonyms to **Puccinia graminis** Pers., **Coleosporium campanulae** (Pers.) Lév., **Milesia scolopendrii** (Fuck.) Arth., or indeed to any rust fungus which has many synonyms. For example, the existence of such synonyms for **Milesia scolopendrii** as **Ascospora scolopendrii** Fuck. (1873) and **Gloeosporium nicolai** Aggeri (1935) clearly indicates the outward appearance of the damage, which is uncharacteristic for the **Uredinales**, as well as the investigator's methods of work.

The taxonomic part of this book is prefaced by a short historical outline of the investigations of rust fungi, by a general part, and by a bibliography on the rust fungi of the USSR. The bibliography includes mainly works of Russian authors and only a few by foreign authors, who describe fungi found in the USSR, and a short list of floras and bibliographical works on rust fungi in countries adjoining the USSR. These references may be useful in the preparation of monographs on individual species or biological groups of rust fungi.

In writing this book we relied on the herbarium of the Institute of Botany of AN SSSR, kept in the Cryptogamic Plant Section of the Institute, and on the herbarium of the All-Union Institute of Plant Protection in Leningrad.

6 We define a species by its inherent morphological features and therefore can classify it from material available in the herbarium without special study of the infectious properties of the fungus. In a few cases biological species were included, viz., the several species of **Melampsora** on

* [The numbers in the left-hand margin refer to the pages of the Russian original.]

[1] [Alternate spelling Transhel' which is a transliteration from the Russian.]

Salicaceae and two to three species of Coleosporium with a well investigated developmental cycle and defined species composition of host plants. The system for the rust fungi in the book was adopted from Dietel (see: Die natürlichen Pflanzenfamilien . . . , vol. 6, 1928, pp. 24—98). According to Dietel, the genera Pucciniostele, Cerotelium, Baeodromus, Ochropsora, and Aplospora belong to Pucciniaceae, but I included them in the family Melampsoraceae when completing work on that family in the years following the war.

After V. G. Tranzschel's death on 21 January 1942 in Leningrad during the siege, for several years virtually no work was carried out on rust fungi. During those years collection of herbarium material was continued in Central Asia, mainly in the Tadzhik, Uzbek, and Turkmen republics. In 1947, when the herbarium of the Cryptogamic Plant Section was made usable, I continued work on the book myself. The loss of the greatest expert on the rust fungi, V. G. Tranzschel, considerably delayed the preparation and classification of the material.

The outline of the morphology and taxonomy of Uredinales for the present edition was adopted from the "Conspectus" (with small changes and additions). The genera Milesia, Hyalopsora, Melampsorella, and Pucciniastrum were prepared by V. G. Tranzschel; the genera Uredinopsis, Thekopsora, Calyptospora, Melampsoridium, Phakopsora, Cronartium, Coleosporium, and Chrysomyxa were prepared by V. G. Tranzschel and myself; I prepared the genera Ochropsora, Melampsora, Pucciniostele, Cerotelium, Baeodromas, Chnoopsora, and Aplospora. The list of hosts and the geographical distribution of species of genera Milesia, Uredinopsis, Cronartium, and Coleosporium were prepared by M. A. Litvinov; I added the historical outline of rust fungi investigations in the USSR, the bibliography, comments on individual works, and also all the data on the biology of rust fungi appearing in the present edition of the book. The original illustrations were made by E. Ya. Zenkova and partly by the artist N. N. Korobov. The index was prepared by E. Ya. Zenkova.

Omissions and errors will probably be found. Indication of these and suggestions for improvements will be appreciated. They should be sent to the following address: Cryptogamic Plant Section of the Institute of Botany of AN SSSR (Leningrad, 2 Prof. Popov Street).

Below is a list of the main monographs used by V. G. Tranzschel and myself in the description of species of the family Melampsoraceae for the present edition.

Arthur, J. Ch. Manual of Rusts in the United States and Canada. Lafayette, Indiana, 1934.

Fisher, Ed. Die Uredineen der Schweiz. Beitr. Kryptogamenfl. Schweiz, Bd. II, H. 2, Bern. 1904.

Gonzalez Fragoso, R. Flora Iberica. Uredales Madrid; tomo I. Género Puccinia. 1924; tomo II. Género Uromyces . . . , Uredales imperfectos. 1925.

7 Grove, W. B. The British Rust Fungi (Uredinales). Cambridge. 1913.

Hariot, P. Lés Urédinées. Encyclopédie scientifique publiée sous la direction du Dr. Toulouse. Bibliothèque de botanique cryptogamique, Paris. 1908.

Klebahn, H. Uredineen. Kryptogamenflora der Mark Brandenburg und angrenzender Gebiete, Bd. Va (Pilze, III), Leipzig. 1914 (1912—1914).

Liro, I. Uredineae Fennicae. Finlands Rostsvampar. Bidrag till kännedom af Finlands natur och folk, 65. Häftet, Helsingfors. 1908.

Migula, W. Kryptogamen-Flora von Deutschland, Deutsch-Österreich und der Schweiz. Bd. III. Pilze, 1, Teil. Gera, R. 1910.

Savulesku, Tr. Monografia uredinalelor din Republika Popularâ Romănâ, I—II. Bucureşti. 1953.

Saccardo, P. Sylloge fungorum, t. t. VII, IX, XI, XVI, XVII, XXI, XXIII (1888—1925).

Leningrad, January 1957 V. F. Kuprevich

9

GENERAL PART

A HISTORICAL OUTLINE OF INVESTIGATIONS OF THE RUST FUNGI (UREDINALES) IN THE USSR

"Rust" of grain and of other agricultural plants has been known since ancient times. The writings of a number of authors who lived before the present era indicate a wide distribution of the rust fungi in Egypt, Greece, Rome, and other ancient states. There is evidence of the presence of rust of grain in the period of Feudal Russia. Attempts have long been made to determine the cause or source of rust. Thus for many years, until it was discovered that rust fungi have many hosts, farmers connected the appearance of rust on grain with **Berberis**. As early as 1780 in a memorandum "O barbarise" (About **Berberis**) published in "Ekonomicheskii magazin" (Economic Magazine) (part I, pp. 198—199), an unknown author writes: "Everybody says that it (**Berberis** — V.K.) is harmful to grain, which, when sown close to a garden where there is a large amount of **Berberis**, suffers a great deal of harm from it. Others assert that it can ruin a whole field of grain . . . while I, as a result of my observations and specially performed experiments — though these may be imperfect and open to doubt — hold the opinion that this is not so; however, I am not completely certain."

The first described case of stem rust of wheat with illustrations of teliospore and urediospore is by the famous Italian investigator F. Fontana. His observations were published in 1767, long before the famous work of Persoon and de Candolle, who defined the place of rust in the plant kingdom. On discovering the cause of stem rust of wheat, Fontana hesitated as to whether to relate it to fungi, to lichens, or to other organisms.

In this outline of the investigations of rust fungi in the USSR, the most significant floristic, biological, and phytopathologic investigations carried out by Russian and Soviet scientists are reported in their chronological order. A more complete documentation of the investigations on rust fungi can be found in the list of publications (pp. 97—254). The list does not pretend to be complete; it can be expanded by the sources in the listed investigations.

FLORISTIC INVESTIGATIONS

Floristic lists from the 18th and early 19th centuries usually contain data on fungi, particularly parasitic fungi. Rust fungi are first mentioned
10 in the lists of Stephan (1792, 1804: **Lycoperdon epiphyllum** = **Puccinia poarum**) and in the detailed treatise of Grigorii Sobolevskii, "Sanktpeter-

burgskaya flora" (St. Petersburg Flora) (1801—1802). In the second part of this treatise (1802, Russian edition) Sobolevskii writes: "Aecidium, the lowest fungus, has a boxlike membranous cap, filled with bare unconnected seeds which are hardly visible to the naked eye . . . Aecidium tussilaginis, growing in a cluster, has yellow capsules, somewhat convex, filled with orange-colored seeds. It lives on the back or under the leaves of the coltsfoot and other plants in the fall" (pp. 378—379).

The first extensive list of fungi in Moscow Province was compiled by G. Martius in "Prodromus florae Mosquensis" (1812, 1817). Its first edition (1812) was lost, except for two copies, during the fire of Moscow; one of these copies was found in the Royal Library in Berlin, the other was in the possession of Gol'dbakh in Moscow. The list of rust fungi in the first edition of "Prodromus" was presented by Magnus (1902). In the edition of 1812, on his authority, 47 names of rust fungi were given. The edition of 1817 contains 259 names of fungi with short diagnoses, among them 79 + 18 names of rust fungi (Aecidium 15, Puccinia 21 + 3, Uredo 43 + 15).

From 1817 to 1830 important catalogs were published by Liboshits (1817) and Gol'dbakh (1820), and a catalog by Jundzill (1830) in which 33 names of rust fungi in Lithuania, Volhynia, and the Ukraine are given. A large list of rust fungi of St. Petersburg Province is found in the well-known catalog of fungi prepared by Weinmann (1836, 1837). In the 1837 catalog 43 names are given (Nos. 1706—1748) with short notes.

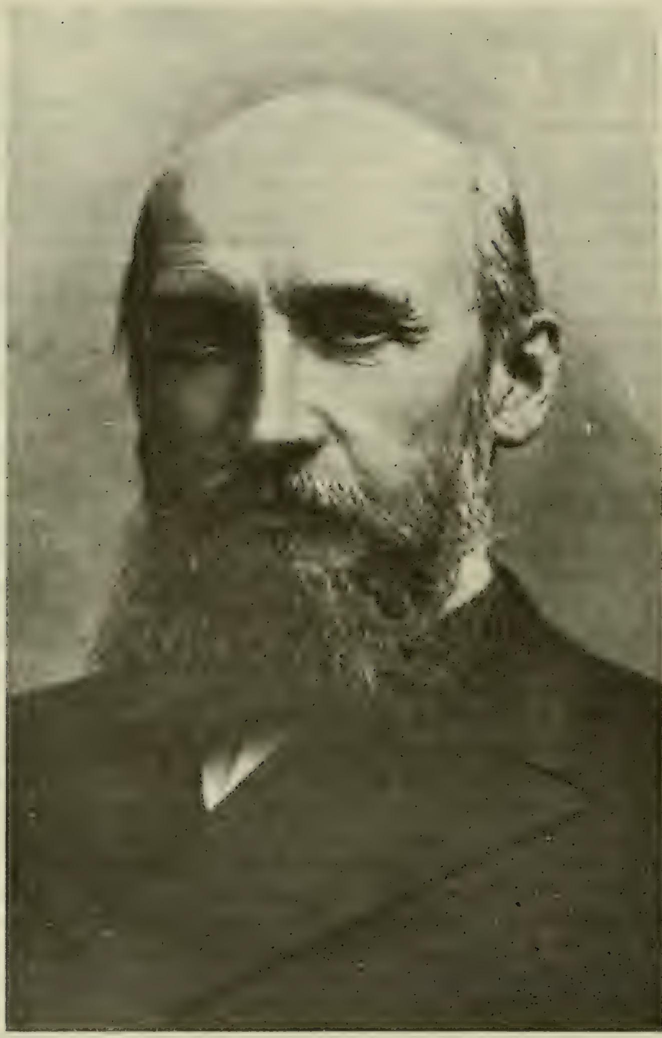
Reports on rust fungi were presented by P. Gopyaninov in his paper, "Griby, pleseni i pyleviki v mediko-politseiskom i drugikh otnosheniyakh" (Fungi, Molds, and Puffballs in Forensic-Medicine and Other Reports) (1848). In the systematic part of the paper (pp. 37—120) harmful fungi mentioned include the following: "rust of field crops," "Puccinia graminis," "filmy rust," "leguminous rust," "Peridermium pini Link," "Aecidium," "Roestellia cancellata Rebent." "If rust appears before flowering," writes Goryaninov, "the grain usually becomes lean." According to the author cold soil, frequent rains with intermittent sultriness, and hot days with cold nights abundant in dew favor the appearance of rust, as well as smut. They seldom appear in mountain crops (p. 40).

Extensive material on rust fungi of the Baltic region was gathered and published in the 1850's by Dietrich (1856, 1859), a great mycologist and one of the first phytopathologists, he compiled lists containing more than 150 names of rust fungi, including several new species.

In the 1870's the mycologist N. V. Sorokin compiled lists of parasitic fungi, including the rust fungi, for Kazan Province, the Urals, the Caucasus, and some other districts. At the same time appeared N. K. Sredinsky's lists (1872—1873) for Novorossiisk County and Bessarabia and that of Ya. Val'ts and L. Rishavi (1872) for Kiev Province.

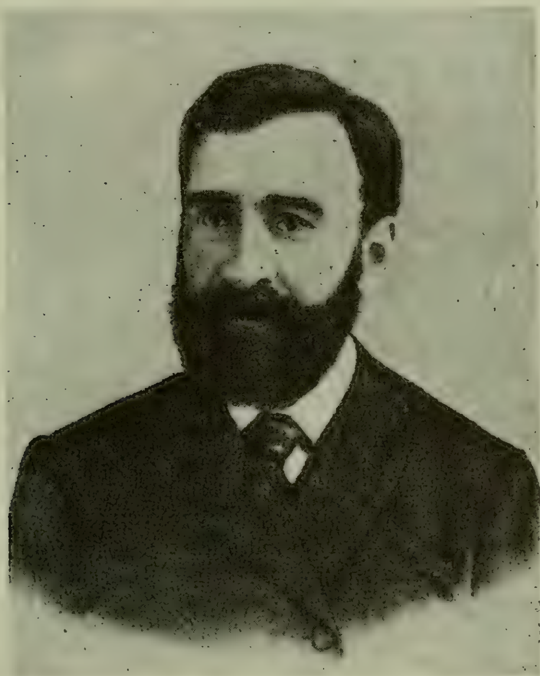
The revival in the investigation of the parasitic fungi in Russia was connected with the work of one of the first Russian mycologists, M. S. Voronin
11 (1838—1903), a student of A. de Bary. By that time heteroecism (change of host plant of rust fungi) had been proved experimentally, mainly by the brothers Tyulyan and A. de Bary.

At the same time one of the greatest investigators of the parasitic fungi, N. M. Mart'yanov, started his work in Minusinsk Territory in Siberia. He was the founder of the Minusinsk Museum. In 1902 the museum collection contained 1,127 species of fungi, mainly parasitic, located on higher plants on which they parasitize. The fungi collected by Mart'yanov were prepared



M. S. VORONIN

and described in a catalog by the Viennese mycologist Thümen (1876–1882), by Saccardo (1889, 1893, 1896), and by V. G. Tranzschel. A small part of this collection was prepared by Romel (Stockholm) and by A. A. Jaczewski (Gzhatsk). Very detailed lists were published by N. M. Mart'yanov himself. Thus, in a list found in "Trudy Obschchestva estestvoispytatelei pri Kazanskom universitete" (Transactions of the Society of Naturalists at Kazan University) (Mart'yanov, 1882) he presented more than 1,100 names of parasitic fungi, among them 168 of rust fungi.



N. M. MART'YANOV

In the 1870's the main centers of Russian mycology were established. In St. Petersburg, M. S. Voronin with his remarkable investigations on **Puccinia helianthi** Schw. initiated experimental mycology; here also there subsequently developed an important center of mycology with which the following mycologists were connected: Kh. Gobi, A. Jaczewski, V. Tranzschel, A. Bondartsev, and N. Naumov. Smaller centers of mycology were established in Kazan (N. Sorokin), Riga (F. Bucholtz), Moscow (S. Rostovtsev), and Kharkov (A. Potebnya). In southern and southwestern Russia the following investigators were active: N. Sredinsky, I. Krupa, F. Błoński, M. Raciborski, A. Elenskii, and others, mainly emigrants from Warsaw University.

From that time the floristic work on higher basidial fungi — **Boletales, Agaricales** — was gradually relegated to the background. The main attention of the mycologists was directed to parasitic fungi, undoubtedly in connection with the damage caused by these fungi to grain and other crops.

The increased interest in this group is also due to the great success in the study of the growth cycle of rust fungi and of a number of other parasitic fungi. The
12 general study of parasitism was influenced by A. de Bary and his students.

The increased interest in botany in Russia was undoubtedly connected with the need to develop agriculture in vast areas in the east and southeast of the country. Many botanical investigations were therefore connected with the activity of the Resettlement Department. Most studies of rust fungi and other parasitic fungi were carried out in the vicinity of the main mycology centers — St. Petersburg, Moscow, and Riga. Significant floristic work was also carried out in the south and southwest of the country.

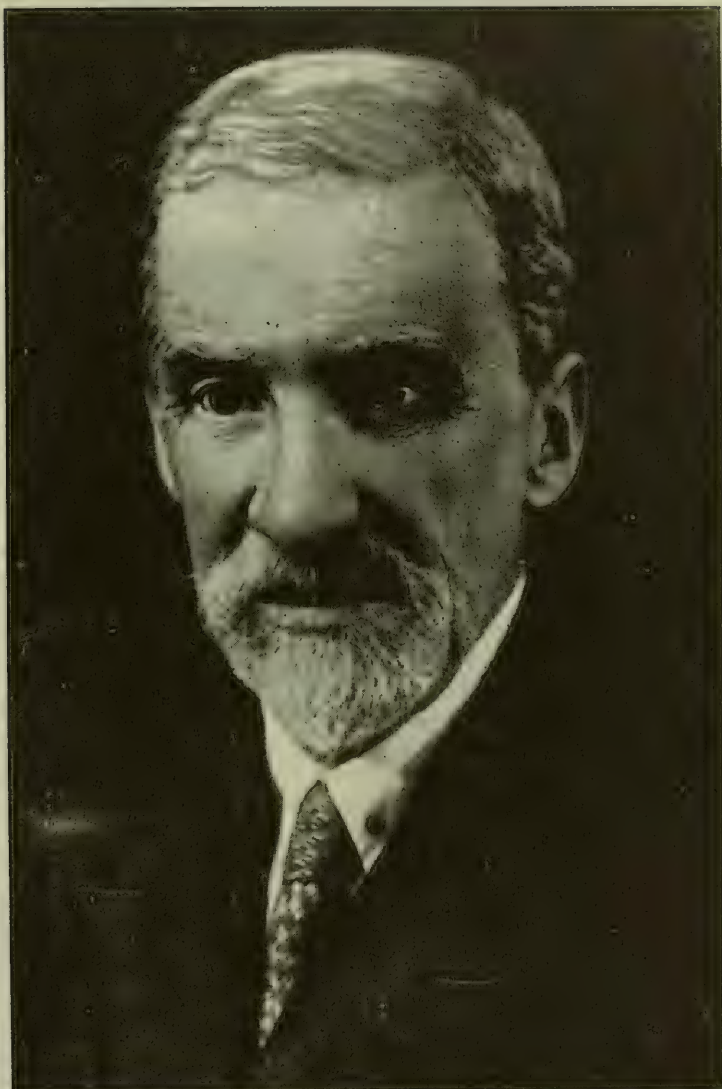
In the late nineteenth and early twentieth centuries catalogs of rust fungi were published from Moscow, Smolensk, Nizhegorod, Tula, Yaroslavl', Perm', Samara, Penza, Simbirsk, Kazan, Kursk, and other provinces. The fullest lists were those of S. Korzhinskii (1885), I. Grachev (1891), A. Jaczewski (1896), I. Serebryannikov (1897), F. Bucholtz (1897a—1897c), P. Syuzev (1899), A. Dmitriev (1902), N. Mosolov (1906), A. Bondartsev (1906), K. Murashkinskii (1911), N. Voronikhin (1911, 1913), N. Trusova (1912, 1913, 1915), N. Dyukina (1914), N. Naumov (1915a), B. Karakulin and A. Lobik (1915). The publication of S. F. Dmitriev (1914) merits special mention for it included, apart from the list of rust fungi (104 species), valuable observations on the growth cycle, the amount of damage done, and the spread of the infection in relation to meteorological conditions and the state of the host plants.

Much attention was given at that time to the study of rust fungi from St. Petersburg Province and adjoining areas, especially Estonia and Latvia. The flora of the rust fungi of St. Petersburg Province was thoroughly investigated by N. Zhilyakov (1890), Kh. Gobi and V. Tranzschel (1891), K. Ivanov (1900), V. Tranzschel (1901), N. Naumov (1913, 1914a, 1915b, 1916), S. Ganeshin (1916), and others. Data on the northwestern districts are included in the floristic works of P. Karsten (1871—1895) and I. Lindroth (1899, 1902). By 1916 about 200 species of rust fungi were identified in St. Petersburg Province and the northwestern districts.

For Latvia and Estonia the most detailed floristic lists after A. Dietrich were published by T. Vestergren (1900;1902), A. Bondartsev (1903), F. Bucholtz (1905a—1907, 1915a—1916), F. Ferle (1906), O. Treboux (1912a; 101 species), and especially by L. Aref'ev (1916a, 1916b). The comprehensive work of the latter author was, to our regret, unfinished.

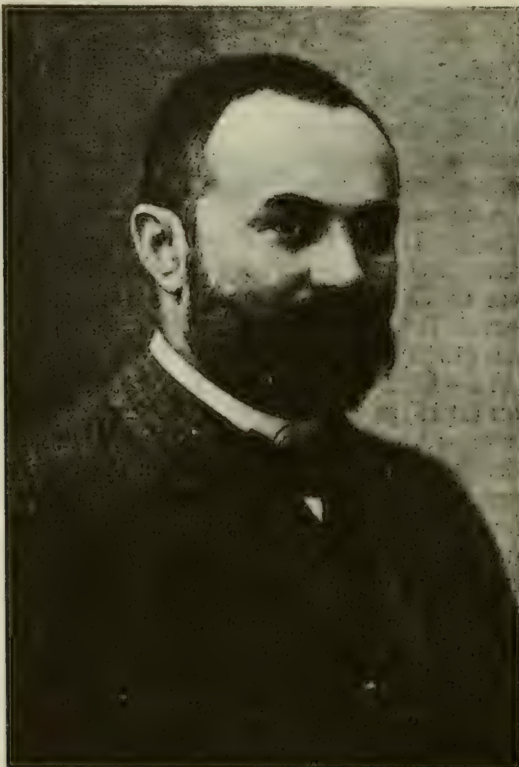
In the following years the study of rust fungi of the Baltic region was continued by Yu. Smarods and E. Lepik. In the review published by Lepik (1939a) about 200 species of rust fungi are critically discussed. A large number of species of rust fungi were included by Yu. Smarods in the exsiccates of parasitic fungi of Latvia (see below).

The mycological flora of the Ukraine and of some southern districts of the European part of Russia was studied intensively. Floristic lists for the Crimea were published by Léveillé (1842), Raciborski (1891), B. Isachenko (1896), V. Varlikh (1896), V. Tranzschel (1901b, 1902, 1904). Detailed lists for Novorossiisk Territory and Bessarabia were compiled by N. Sredinsky, 48 species (1872—1873, 1873) and K. Dekenbakh, 25 species (1899—1900a,
13 1899—1900b). Particularly thorough investigations were carried out by A. Bondartsev in Kursk Province (1906) and by A. Bondartsev and L. Lebedeva in Voronezh Province (1914); more than 100 species of rust fungi appear in the lists of these authors. There are two lists of fungi from Kharkov and Kursk provinces published by A. Potebnya, and a list of O. Treboux for Kharkov Province which includes 121 species of rust fungi.



V. G. TRANZSCHEL

Among other floristic works, the more extensive lists of fungi are by P. Nagornyi (1911–1916), N. Voronikhin (1911), O. Treboux (1912), V. Siemaszko (1913), G. Spagorov (1916), A. Sokolov (1916), S. Shembel' (1915, 1918), etc.



F.V.BUCHOLTZ

In Belorussia and Lithuania the parasitic fungi were studied by F. Błoński (1888, 1889, 1896), in whose lists up to 40 species of rust fungi are mentioned, K. Rouppert and Namysłowski (1909), A. Sutulov (1912), V. Siemaszko (1914, 1924), and others. Reliable lists were published by Kastory (1912) and by S. Shembel' (1913). Later, floristic lists for Lithuania were published by B. Szakien (1926), S. Tumilowiczowna (1925), and I. Trzhebinskii (1936). A summary of rust fungi of Lithuania is contained in the detailed work of A. Minkevichus (1937) and the later published supplement (1949) which together include 125 species.

For the Western Ukraine (Galicia, the Transcarpathian Region, and other districts) there are detailed lists of rust fungi by Krupa (1886, 1888) and M. Raciborski (1888). Later, lists were published by G. Bobyak (1907), K. Rouppert (1909, 1911c), A. Wróblevski (1913, 1914, 1916, 1922), and F. F. Petrak (1925). In A. Wróblevski's list for the Western Ukraine and for several districts in Poland and Czechoslovakia, 251 species of rust fungi are included. The most complete lists of rust fungi for Galicia and Bukovina were published by B. Namysłowski (1911a, 1911b, 1914). The lists contain as many as 270 species of rust fungi; the data were from the author's own investigations and from literature.

14 The mycoflora of the Caucasus was investigated in prerevolutionary times to approximately the same extent as the mycoflora of the central

districts of European Russia. Rust fungus lists of N. Speshnev (1895, 1901) for Tiflis Province contain about 40 species. More complete lists were published by Yu. Voronov (1908, 1910, 1915, 1922–1923), Siemaszko (1915, 1921, 1923), P. Nagornyi (1916a, 1916b), and N. Voronikhin (1914a–1919). Lists by K. Ivanov (1899, V. Tranzschel (1908), A. Elenkin and I. Ol' (1912) should also be mentioned.

"Svod svedenii o mikoflore Kavkaza" (A Summary of Data on the Mycoflora of the Caucasus), published by Yu. Voronov (1915, 1922–1923), contains an extensive bibliography and a list of collectors.

The most extensive investigations of Siberian rust fungi were carried out by N. Mart'yanov. A considerable part of this investigation, as mentioned above, was prepared and published by Thümen, who worked for many years as a pharmacist in Minusinsk, and by Saccardo and other mycologists. At the end of the last century, N. Sorokin and N. Bush (1892) compiled lists of fungi, including rust fungi, of Siberia and the Far East; lists were compiled by S. Rostovtsev (1898) for the vicinity of Tobol'sk, by G. Stukov (1907) for eastern Transbaikalia, by P. Syuzev (1910) for the Far East and northern Manchuria, by A. Ivanitskaya (1911–1912, a manuscript) for the Tomsk Subregion, by S. Ganeshin and V. Tranzschel (1913) for Irkutsk Province, by V. Ivanovskii (1912–1913, a manuscript) for the vicinity of Tobol'sk, by V. Tranzschel with the assistance of N. Voronikhin (1914a) for Kamchatka, according to the data of the Kamchatka expedition of F. Ryabushinskii, and by N. Naumov (1914b) for the Far East. Many collections were almost completely identified by V. G. Tranzschel, and the corresponding lists (for example those of Stukov, Ivanitskaya, Ganeshin, and Ivanovskii) have still not lost their value for floristic work on Siberia and the Far East.

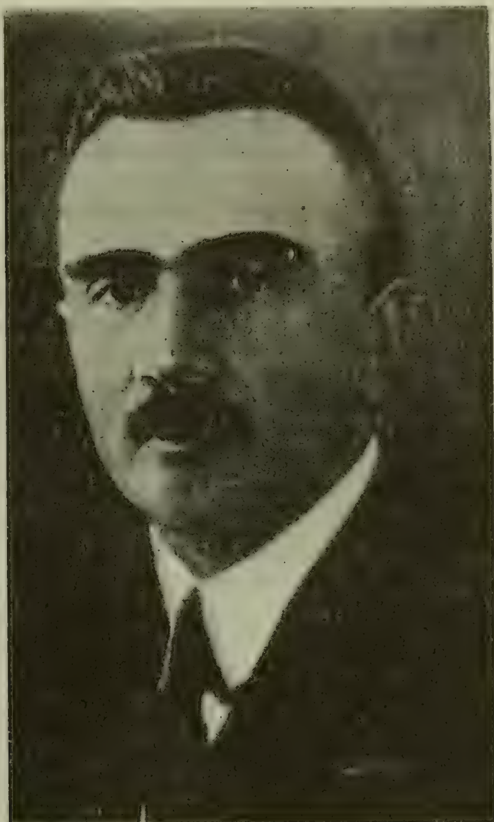
Systematic investigations of rust fungi of the Far East were carried out by V. L. Komarov during his journeys in 1895–1898, 1913, and 1918; 200 species of rust fungi were collected by V. L. Komarov and identified with the assistance of V. G. Tranzschel. Mention should be made of the important role of the collector P. Mikhno (from the city of Kyakhta, formerly Troitskosavsk) in the study of rust fungi of West Siberia: he sent valuable material to V. G. Tranzschel. Of almost equal importance for the study of fungi from the vicinity of Tobol'sk was the herbarium of V. Ivanovskii, and for the vicinity of Krasnoyarsk – the herbarium of A. Yavorskii; in the Far East (from 1901 to 1910) collection of fungi was carried out by N. Shestunov.

For Central Asia the most extensive work on rust fungi, which is still of great importance, is V. L. Komarov's "Parazitnye griby gornogo Zeravshana" (Parasitic Fungi of the Mountainous Zeravshan Area), which was published in 1895 and which describes 76 species of rust fungi. Among other works on Central Asia published before the revolution, mention should be made of the list of N. Speshnev (1901a) for the Transcaspian region and Turkestan, and the list of Rostrup (1907), based on data of the second expedition of Olufsen, in which 25 species of rust fungi from the Fergana Valley and the Pamir are indicated. Several species of rust fungi from Central Asia are described by N. Sorokin, A. Jaczewski, and V. Tranzschel.

On the whole, the prerevolutionary period of investigation of rust fungi, as well as of other parasitic fungi, can be defined as a period of accumulation
15 of data on species composition, distribution, and the economic significance of parasites of cultivated and wild plants. Many lists (those of V. Tranzschel, V. Komarov, A. Jaczewski, etc.) contain a considerable number of new species and species first found in the USSR. Particularly rich data were accumulated for the European part of Russia, especially for the central provinces

V. L. KOMAROV

and for several western and southern provinces. Less attention was devoted to Belorussia, some parts of the Ukraine, some districts of the Caucasus, a number of regions of the central and eastern parts of European Russia and in particular Central Asia. The relatively small number of general publications in that period is due to the incompleteness of the collected data.



B. NAMYSŁOWSKI

The study of parasitic fungi, particularly of those which cause disease in agricultural plants, has increased considerably since the October Revolution and has assumed a more definite direction. Expansion of industrial and research institutes concerned with plant protection contributed to this. Thus, in 1930 these included 7 plant protection departments of the People's Commissariat for Agriculture, 3 republic plant protection stations, and 68 stations at the level of territories, provinces, and subregions. Plant protection was improved after the formation, in 1930, of the All-Union Society for the Control of Agricultural Pests. Of great importance was the establishment of plant protection departments and of new agricultural colleges, and the introduction of courses on the lower plants and phytopathology in many colleges.

The main centers of floristic research both then and now are the following: Leningrad, Moscow, Kiev, Kharkov, Tashkent, Tomsk, Omsk, Baku, Tbilisi, Erevan, Saratov, Vladivostok, Kazan, Minsk, Vilnius, Riga, Alma-Ata, and several less important centers.

Material has been accumulated in the central investigating institutions (The Institute of Botany of AN SSSR, the All-Union Institute of Plant

16 Protection, the Moscow, Kiev, Tomsk, and Central Asian universities), facilitating the writing of large floristic and phytopathologic works of local importance. To such mycological works belong: "Opredelitel' gribov" (A Key to Fungi) by A. A. Jaczewski (1913), "Osnovy mikologii" (Fundamentals of Mycology) by the same author (1933), "Golovnevye griby" (Ustilaginaceae) by L. Gutner (1941), "Nesovershennye griby (Fungi Imperfecti), vols. 1 and 2 (1939, 1949) by N. Vasil'evskii and B. Karakulin, "Opredelitel' shlyapochnykh gribov" (Key to Hymenomycetes) by L. Lebedeva (1948), "Mikologiya" (Mycology) by L. Kursanov 1933, 1940), "Muchnistorosyanye griby Srednei Azii" (Farinaceous Fungi of Central Asia) by P. Golovin (1949), "Flora gribov i slizevikov Sibiri" (A Flora of the Fungi and Slime Molds of Siberia) by N. Lavrov (1937, 1948), "Opredelitel' parazitnykh gribov po pitayushchim rasteniyam flory BSSR" (Key to Parasitic Fungi on Host Plants of the Belorussian SSR Flora), vol. 1 (1938), a similar work by N. Lavrov for Siberia (1932), "Trutovye griby Evropeiskoi chasti SSSR i Kavkaza" (Polyporales of the European Part of the USSR and of the Caucasus) by A. Bondartsev (1953), "Golovnevye griby Azerbaidzhana" (Ustilaginaceae of Azerbaijan) by V. Ul'yanishchev (1949), "Vyznachnyk hribiv-shkidnykiv kul'turnykh roslyn" (A Key to Fungal Pests of Cultivated Plants) by N. Pidoplichka (1938) and by the same author "Gribnaya flora grubykh kormov" (Fungal Flora of Raw Foodstuffs) (Pidoplichka, 1953), the works of Naumov and of other authors.

V. G. Tranzschel published theoretical treatises on rust fungi: "Rzhavchinnye griby v ikh otnoshenii k sistematike vysshikh rastenii" (The Rust Fungi and their Relation to the Systematics of the Higher Plants) (1927, 1936), "Pravilo Fishera" (Fischer's Rule) and "Metod Transhelya" (Tranzschel's Method) (1934b), "Promezhutochnye khozyaeva rzhavchiny khlebov i ikh rasprostranenie v SSSR" (Intermediate Hosts of the Rust of Grain and their Distribution in the USSR) (1934b). N. A. Naumov published a monograph "Rzhavchina khlebnykh zlakov SSSR" (The Rust of Grain-Crops in the USSR), (1939); a critical review was published by us: "Brachyformy roda Puccinia Pers. (Uredinales), parazitiruyushchie na vidakh gruppy Anthemideae sem. Compositae (Brachy-forms of the Genus Puccinia Pers. (Uredinales), Parasitizing on Species of the Group Anthemideae of the Family Compositae) (Kuprewicz, 1934); K. S. Sergeeva published a critical investigation "Rzhavchina klevera i lyutserny" (The Rust of Clover and Lucerne) (1953) and a number of others.

Of great importance in the study of USSR rust fungi was the publication in 1939 of V. G. Tranzschel's "Conspectus," in which the results of fifty years of the author's investigations are summarized. Apart from the exhaustive list of rust fungi provided with critical notes and basic quotations, the book contains a detailed outline of the morphology, taxonomy, geographical distribution, and biology of rust fungi.[1]

Floristic work after the October Revolution was concerned to a considerable extent with less investigated districts. Thus, lists of fungi for the Belorussian SSR were published by L. Lebedeva (1925a, 1925b, 1935) — 49 species of rust fungi; by S. Tupenevich (1930, 1932b) — more than 100 species; by V. Kuprewicz (1931), and by others.

The most extensive lists for the Kola Peninsula and the Karelian SSR [now ASSR] were written by L. Lebedeva (1933), L. Gutner and M. Kokhryakov (1940).

[1] This outline in an abbreviated form is given in General Part of this book.

In "Obzor rzhavchinnykh gribov Latviiskoi SSR" (Survey of Rust Fungi of the Latvian SSR) by Yu. Smarods (1952) 218 species are indicated, among them some species that are new for the western regions of the USSR; new host plants are also quoted.

Lists were published on the central regions of the European part of the USSR by V. Bakhtin (1922, 1923), P. Syuzev (1924), A. Alekseev (1927), K. Alyavdina (1928), L. Kazakevich and A. Prisyazhnyuk (1932), N. Ryakhovskii (1935), and E. Isaeva (1952).

Floristic lists for the Ukraine were compiled by V. Bondartseva-Monteverde (1921), M. Tselle (1925), Z. Hizhyts'ka (1926, 1929), V. Hrodzin'-
17 ska (1929), S. Moskovets (1933), S. Yllychevs'kyi (1938), Z. Levitskaya (1949), I. Rayevs'ka and K. Komarets'ka (1949). New species of rust fungi were generally absent from these lists.

A large catalog with detailed diagnoses of rust fungi of the Crimea appears in the work of S. Gutsevich (1952) which sums up data of various collectors, mainly of V. Tranzschel; a great part of it deals with the rust fungi collected by the author.

N. A. NAUMOV

A list of rust fungi of the Bashkir ASSR was published by S. Morochkovs'kyi (1948). It contains new host plants not indicated in the "Conspectus" of V. G. Tranzschel.

An expànded critical list of parasitic fungi of the Caucasus was composed by N. Voronikhin (1927). A detailed description of 160 species of rust fungi from the Armenian SSR is found in the comprehensive investigations of D. Teterevnikova-Babayan (1952). A considerable number of species is indicated in the floristic works of A. Lobik (1926, 1928a), Z. Chernetskaya (1929), and D. Teterevnikova-Babayan (1940, 1948), T. Angabadze (1951), I. Nakhutsrishvili (1953), E. Eristavi and Targamadze (1953). A summary by A. Lobik, "Bolezni i mikologicheskaya flora kul'turnykh rastenii Kavkaza" (Diseases and Mycological Flora of Cultivated Plants of the Caucasus) (1940 (?)), a manuscript of over 2,500 typed pages is kept in the Institute of Botany of the AN SSSR), contains detailed descriptions of rust fungi, mainly of the cultivated plants.

Works concerning Siberia and the Far East are those of V. Komarov (1926), V. Tranzschel (1933, 1936, 1938, etc.), M. Ziling (1936), K. Murashkinskii (1925), K. Murashkinskii and M. Ziling (1928a, 1928b), P. Mikhno (1938, manuscript), A. Azbukina (1952), and of others. In the lists many new species for the Far East are mentioned, especially by V. Komarov and V. Tranzschel. As previously mentioned, N. Lavrov published large works on the mycoflora of Siberia (1926a, 1926b, 1937, 1948), the most important being "Flora gribov i slizevikov Sibiri" (Flora of the Fungi and Slime Molds of Siberia) (1937, 1948).

A number of floristic works concerning Central Asia were published mainly by the mycologists and phytopathologists of Tashkent. Most exhaustive lists were given by P. Estifeev (1927) and G. Zaprometov
18 (1926, 1928a). The works of P. Golovin (1941, 1950a) are comprehensive. The detailed work of Ya. Korbonskaya, "Rzhavchinnye griby Tadzhikistana" (Rust Fungi of Tadzhikistan) (1954), should also be mentioned; this contains a detailed description of 178 species, including 7 new species. New original material is presented in the publications of I. Kataev (1949a, 1951a, 1951b) concerning the Turkmen SSR. A catalog of rust fungi in the area of the Varzob Mountain Botanical Station (Gissar Range) was published by V. Kuprewicz (1951). Also of interest are the floristic data of B. Kalymbetov (1953) from the area of the Turkmen Canal and of E. Koshkelova (1955) concerning the Kopet Dagh Mountains.

The lists of rust fungi of Central Asia, Siberia, and the Far East are distinguished by the abundance of species that were previously unknown in the USSR and a great number of altogether new species. The number of new species in the works of V. Komarov, V. Tranzschel, P. Golovin, G. Zaprometov, A. Sol'kina, V. Kuprewicz, Ya. Korbonskaya, and I. Kataev reaches 100.

Several of the new species of rust fungi are described for the Caucasus (D. Teterevnikova-Babayan).

The lists of fungi of the European part of the USSR usually contain no new species of rust fungi. The main value of these lists lies in the definition of species distribution according to areas, particularly in the case of the more harmful or rare species; notes on the frequency of occurrence and the extent of the disease of the host plants, which appear in the lists, may be used for the determination of the degree of harmfulness of each species, its biological properties, etc. Thus the presence of **Thekopsora padi** (Kze. et Schm.) Kleb. on cherry in Kuibyshev Region, where there is no **Picea excelsa** — the host of the aecia of this parasite — indicates the ability of this fungus to overwinter in the urediospore stage.

The herbarium of rust fungi founded by V. G. Tranzschel, A. A. Jaczewski, and A. S. Bondartsev is kept in the Cryptogamic Plant Section of the Institute of Botany of AN SSSR. The herbarium includes the collections of V. G. Tranzschel, V. L. Komarov, A. A. Jaczewski, F. V. Bucholtz, A. S. Bondartsev, N. N. Voronikhin, G. S. Nevodovskii, B. P. Karakulin, N. I. Vasil'evskii, A. I. Lobik, V. N. Bondartseva-Monteverde, P. I. Nagornyi, and of many others. Many species of rust fungi described by different authors are in the form of exsiccates, in particular those described by A. Dietrich in Plantarum florae balticae cryptogamarum, Centuriae I—IX, Revaliae, 1952—1857 (192 specimens of rust fungi);[1] N. Sredinsky (1876) (32 species of rust fungi); F. Thümen, Mycotheca universalis, Centuriae I—XXIII (diagnoses: Flora, 1875—1884; Index alphabeticus, centurianum I—XII, 1879, p. 1—35); N. Mart'yanov, Fungi minusiensis exsiccati (51 species of rust fungi collected in the Sayan Mountains and in the vicinity of Minusinsk; list, 1880); A. Jaczewski, V. Komarov, and V. Tranzschel, Fungi Rossiae exsiccati, issues I—VII, 1895—1899; V. Tranzschel and I. Serebryannikov, Mycotheca Rossica, fasc. I—VII, 1910—1912; F. Bucholtz, "Gerbarii russkikh gribov" (Herbarium of Russian Fungi), series A, issues I—II and series B, issues X—XII, 1915—1916 (continued with the assistance of A. Bondartsev), series A, issues III—IV, series B, issues XIII—XIV, 1917—1918; V. Siemaszko, (Fungi bialowiezenses exsiccati, cent. I—II, (list: Siemaszko, 1923—1925), G. Nevodovskii, "Griby Rossii" (Fungi of Russia), 1909—1924; Yu. Smarods, Fungi latvici exsiccati, fasc. I—XXVII, 1931—1956; E. Lepik, Fungi Estonici exsiccati, I—IV, 1931—1938; A. Minkevichus, Flora Lituana exsiccata, Fungi parasitici fasc. I—II, 1932—1937. Nearly all the exsiccates of the Russian fungi are found in the Cryptogamic Plant Section.

19

FOREST DISEASES

Forest diseases caused by rust fungi, mainly by **Peridermium pini** (Willd.) Lév. and **Melampsora pinitorqua** Rostr. first drew the attention of foresters in the second part of the last century. By that time, the wide distribution of and the damage done by these fungi, especially by **Peridermium pini**, was established.

The first thorough review of tree diseases was published by V. Sobichevskii (1875) in three parts under the general title, "Sovremennoe sostoyanie rastitel'noi patologii derev'ev i znachenie rastitel'nykh parazitov-gribkov pri vzrashchenii lesa" (The Present State of Plant Pathology of Trees and the Significance of Parasitic Fungi in the Growing Forest). The second part is devoted to the rust fungi, of which 15 species are described in detail on the basis of data of foreign authors and his own observations. This composition, apart from the work of S. Rozanov (1871) which contains a review of forest diseases, is the first original Russian book on forest pathology.

In the following years several small memoranda were published by P. Zhudra (1882), E. Kern (1883, 1886a, 1886b, 1895), V. Politaev (1894), V. Sobichevskii (1897), and others concerning **Peridermium pini** and **Melampsora pinitorqua**. At about this time the texts of Gartig (1894) and Frank (1899) were published in Russian translation.

[1] See also N. Annenkov (1897) in the bibliography.

A. A. JACZEWSKI

Of great interest are the observations and investigations of Stychinskii (1893), I. Yanitskii (1895), P. Matulyanis (1897), and S. Konarzhevskii (1898). According to Stychinskii, who observed damage done by **Peridermium pini** in a forest estate in Vilnius Province, the fungus settles at that height of the tree where the cross section is 25—30 years old and always on the southern or western side of the trunk, that is on the side subjected to the prevailing winds and most exposed to the sun. In young and medium-aged plantings the fungus was not found at all. A detailed investigation of the effect of **Peridermium pini** on the growth and the condition of affected trees was carried out by I. Yanitskii. In the investigation of P. Matulyanis on **Peridermium pini,** carried out in a public forest estate in [former] Kovno Province, the distribution rate of the fungus around the trunk of affected
20 trees and the duration of the disease for trees of different ages was established for the first time. Thus, according to the author, the speed at which the fungus moved around the trunk was on the average 0.47 of a vershok[1] per year in trees 35—130 years old. According to Matulyanis, it takes from 13 to 25 years for the infection to destroy a tree, depending on the age of the tree.

N. SMARODS

The author attributes to birds a great role in the distribution of **Peridermium pini.**

[1] [2.089 cm; a vershok is 4.445 cm.]

In 1897 a book by A. A. Jaczewski was published, "Parazitnye griby russkikh lesnykh porod" (Parasitic Fungi of Russian Forest Species). In this book rust fungi are described in detail, among them Chrysomyxa abietis (Wallr.) Wint., Melampsora (Melampsoridium) betulina Wint., Cronartium ribicola Dietr., Puccinia buxi D. C. Moreover, data are included on the distribution of the fungi and the damage caused by them to plants in Russia, and methods are indicated for their control.

The book was the first big handbook on forest phytopathology to be published in Russia and was superior to similar works of foreign authors.

Among the works published at the beginning of the present century, mention should be made of the lists of wood-destroying fungi by A. S. Bondartsev (1912a) and S. Vanin (1916, 1922). Also of interest are the observations of K. Baranov (1903) and S. Konarzhevskii (1908) on Peridermium pini.

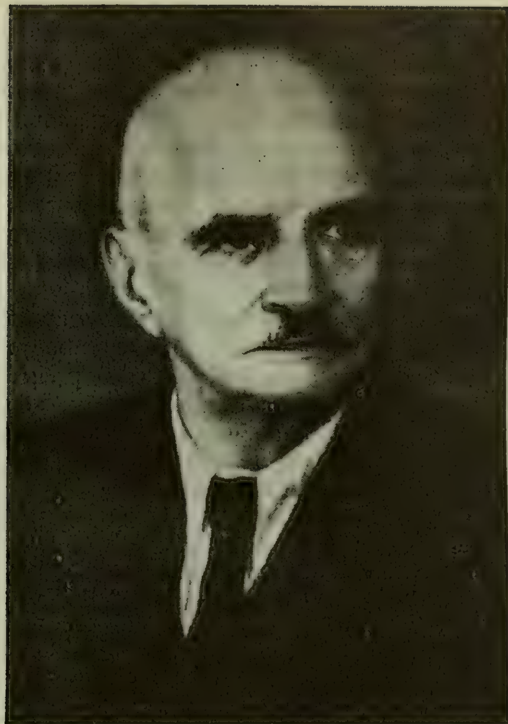
After the October Revolution an important investigation on Peridermium pini was published by A. Vlasov (1929), who studied the biology of the fungus, the processes that take place in the injured tissues, the damage caused by the disease, and measures for its prevention. The works of A. Yunitskii (1927, 1928) and P. Troshanin (1929, 1932, 1938, 1947) were concerned mainly with observations on Melampsora pinitorqua (Tatar ASSR, Mari Autonomous Region [now ASSR]).

An important role in the study of tree diseases and in the training of specialists in forest phytopathology was played by S. I. Vanin, who died an untimely death in 1951. For many years he was head of the Department of Plant Protection of the Academy of Forest Technology (Leningrad). A famous textbook, "Lesnaya fitopatologiya" (Forest Phytopathology), published in 1948 in its third edition, and a number of other works of S. I. Vanin contributed to forest phytopathology education in the USSR. The textbook of S. I. Vanin is the only handbook on phytopathology in the USSR.

Floristic and phytopathologic works on the fungi of large forests of the Far East were published by L. Lyubarskii (1934, 1936); among these, great interest attaches to the investigation of fungal diseases of the South Ussuri Territory forests (1934), in which mention is made of the distribution of and damage caused by Thekopsora padi Diet. to Yeddo spruce and the little known disease of Phellodendron, Coleosporium phellodendri Kom. The works of V. Shafranskaya (1940, 1951) contribute new data on the incubation period of the aecial phase of Melampsora pinitorqua and on other biological questions regarding this fungus. The rust fungi of forests of the Lithuanian SSR are presented in the work of A. Minkevichus (1950).

Extensive floristic data for the Ukrainian SSR are contained in the articles of V. Bratus (1949), E. Isaeva (1952), S. Morochkovskii (1952, 1953), M. Parfilova (1952), and G. Radzievskii (1952); for the Armenian SSR — in the lists of L. Kanchaveli (1942), E. Arutyunyan (1950, 1953), D. Teterevnikova-Babayan (1951), M. Mkhitaryan (1952), and in other less
21 important works (see "Floristic Investigations").

For the Kazakh SSR there are the works of B. Kravtsev (1933, 1948a, 1948b, 1950) on the diseases of the Siberian fir, wild apple tree, Schrenk spruce, and poplars, and also a review by S. Shvartsman (1950). Concerning the Uzbek SSR and the Tadzhik SSR, apart from the works indicated in the floristic review, the articles of B. Kleiner (1951a, 1951b) on the diseases of savin and bitter almond should be mentioned.



N.N.VORONIKHIN

Some works on forest phytopathology describe the formation of protective forest belts in the southeast of the European part of the USSR and in other districts. These are mainly reviews concerned with present-day knowledge of the role of plant diseases in forest cultivation, for example: the articles of S. Vanin (1949), of I. Beilin (1949a), of V. Gulyaev (1949), and of several others. A number of articles and special editions were published for the many workers employed in the cultivation of protective forest plantings, in particular by A. Prisyazhnyuk (1949a) and I. Brezhnev (1950a). In the brochure of I. Brezhnev 30 species of rust fungi parasitizing on woods and brushwood are described in detail and prevention measures are indicated. The articles of V. Gulyaev (1954) and O. Komirna (1952) are concerned with the results of mycological investigations of young forest belts. A brief acquaintance with the works on forest phytopathology, in particular those on the rust fungi harmful to forests, already indicates the insufficiency of the investigations carried out. Well investigated forest diseases are few. Many districts of the USSR, characterized by unique plant combinations, have not been investigated at all. This applies to the vast Siberian taiga areas and the large forests concentrated in the southern mountainous districts of the USSR. The absence of any data for these districts renders difficult the work on forest pathology needed for the proper exploitation of these large forest areas.

PHYTOPATHOLOGIC INVESTIGATIONS

Phytopathologic and floristic work are closely related; separation between them is necessarily artificial. Many of the floristic works
22 mentioned above contain valuable data on the diseases of cultivated plants, the damage caused by the diseases, the biology of the rust fungi, etc. The short outline of phytopathologic investigations to be presented can be supplemented by many works mentioned previously.

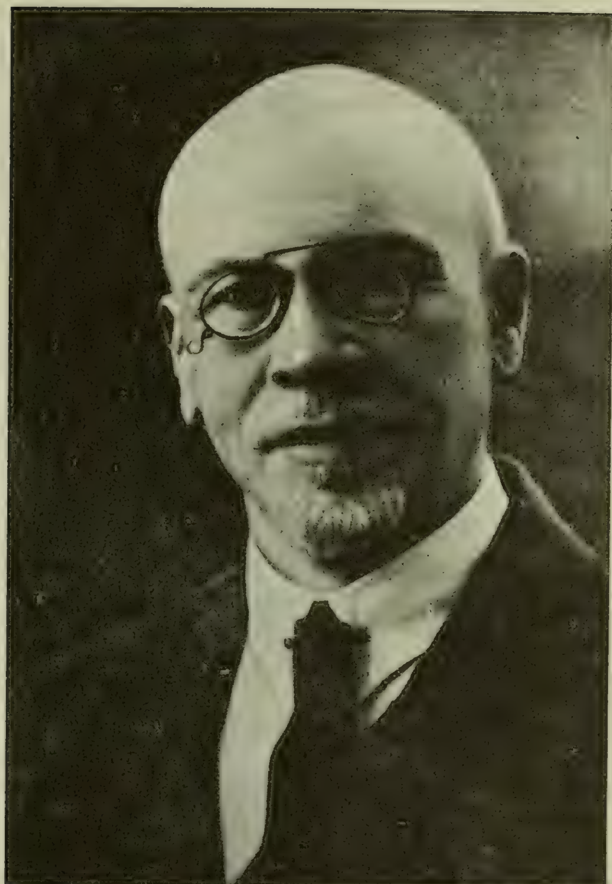
The damage to grain caused by rust fungi was noticed long before the actual cause of the disease was known. One of the first Russian authors, P. Goryaninov (1848), indicated the damage caused by rust fungi to field crops and to cultivated leguminous plants. The first extensive paper on the diseases of agricultural plants and valuable tree varieties was published in the form of essays by S. Rozanov in 1870. One year later these were published as a book entitled "Bolezni rastenii, prichinyaemye rastitel'nymi parazitami" (Plant Diseases Caused by Plant Parasites). Fifty pages of the book are devoted to the rust fungi. The author describes in detail rust fungi of grain, beet, legumes, raspberry, flax, fruit trees, wild-growing trees, and other plants. These descriptions are supplemented with 36 illustrations. A number of parasitic fungi are discussed in detail, and the author attaches great importance to the disturbance in the normal functional activity of the host plant and destruction of its tissues and organs by the parasite. Methods of prevention are indicated. S. Rozanov's paper is an original work in which, together with the data of foreign authors, the author's own observations are also reported.

The less original phytopathologic works of Ya. Val'ts were published at the same time in the form of essays (1867, 1871, 1873).

A number of crop diseases are described in "Kurs mikologii" (A Course in Mycology) as given in lectures by M. Voronin in 1874—1875 at St. Petersburg University; the review of rust fungi (pages 37—64) contains original investigations by the author. In the same years a paper was published by N. Sorokin, "Osnovy mikologii s obozreniem ucheniya o zaraznykh boleznyakh" (Fundamentals of Mycology and a Review of the Study of Infectious Diseases) (1878), in which data are given on rust fungi harmful to crops.

A book very popular for a long time among mycologists and phytopathologists was "Kratkii ocherk mikologii s ukazaniem gribov, naibolee vrednykh v sel'skom khozyaistve i lesovodstve" (A Short Outline of Mycology, with Indication of the Fungi Most Harmful to Agriculture and Forestry) (1897). This was the reference book until 1933, when two large handbooks were published: "Osnovy mikologii" (Fundamentals of Mycology) by A. Jaczewski and "Mikologiya" (Mycology) by L. Kursanov. "Kratkii ocherk mikologii" (A Short Outline of Mycology) by I. Borodin nevertheless deserves to be followed.

At the end of the last century two large works appeared — "Vazhneishie bolezni nashikh kulturnykh rastenii, prichinyaemye parazitami gribami" (The More Important Diseases of Our Cultivated Plants Caused by Parasitic Fungi) by V. Varlikh (1897, 1898) and "Patologiya rastenii" (Plant Pathology) by S. Rostovtsev (1898; in the third edition — "Fitopatologiya" (Phytopathology) (1908). These two works, particularly the latter, form the basis of phytopathologic education in Russia. In both books an important place was assigned to rust fungi and to measures for their prevention.



A.A.ELENKIN

It is impossible not to mention the educational value for schools of a series of visual aids such as "School herbariums" of fungal diseases of cultivated plants prepared by visual-aid workshops in Kharkov, Poltava, and Moscow. These publications were begun in Kursk in 1906, where between 1906 and 1914 a series of editions of the "School herbarium" (field-garden-orchard) appeared which were provided with a detailed explanatory text
23 and indicated prevention measures.

In the following years great importance attached to publication of the works of A. Jaczewski, "Rzhavchina khlebnykh zlakov" (The Rust of Grain Crops) (1901, 1909), and of A. Bondartsev, "Gribnye bolezni kul'turnykh rastenii . . ." (Fungal Diseases of Cultivated Plants . . .) (1912b). An important paper of A. Jaczewski "Bolezni rastenii" (Plant Diseases) (1910, 1911), begun by the author at the suggestion of the Department of Agriculture, remained unfinished. The reason was that Jaczewski became interested in the fungal scheme of Brefel'd and in his opinions; thus in publishing new investigations A. Jaczewski faced the need for radical revision of material already published, viz., the two last issues of "Bolezni rastenii."

N.N.LAVROV

The most successful book on phytopathology at this time was that of A. Bondartsev; its second edition was published in 1927 and its third in 1931. A. Bondartsev's book was for a long time practically the only reference book for study and determination of the cause of a number of plant diseases and their prevention. This excellent book, especially its last edition, still remains unsurpassed both in clarity and correctness of presentation and in its accuracy.

In the first decade of this century through the beginning of the second decade, apart from the work of A. Jaczewski, S. Rostovtsev, V. Varlikh, and A. Bondartsev, a great contribution to the study of agricultural diseases was made by A. Elenkin, who from 1906 to 1912 was head of the Central Phytopathologic Station in St. Petersburg. Under his editorship were issued the journals "Listok dlya bor'by s boleznyami i povrezhdeniyami kul'turnykh i dikorastushchikh poleznykh rastenii" (Bulletin on the Control of Diseases and Damaging of Cultivated Plants and Useful Wild Plants) (1906) and "Bolezni rastenii" (1907—1912). Among other phytopathologists at that time, those who contributed significant works were I. Serbinov (Bondartsev and Serbinov, 1913), "O boleznyakh yagodnykh kustarnikov i ogorodnykh rastenii" (Diseases of Berry Bushes and Vegetables), K. Murashkinskii (1910, 1912) on diseases of agricultural plants of Nizhegorod and Moscow provinces, I. Vol'skii (1910) on Podol'sk Province, I. Serbinov (1914) on Astrakhan Province, A. Lobik (1914) on Terek Region. In reports on the work of the Stavropol Entomology
24 Department data are presented on the distribution of rust fungi on cultivated plants (Nagornyi, 1914, 1916a, 1916b), a detailed review of plant diseases of the Caucasus (Nevodovskii, 1912, 1914), and lists of plant diseases of Turkestan (Zaprometov, 1915, 1916, 1917).

Of great importance in the investigation of rust fungi were the periodicals edited in St. Petersburg. Many articles and notes are contained in the issues of the journal "Bolezni rastenii" edited by the Central Phytopathologic Station (from 1913 — the Department of Phytopathology at the St. Petersburg Botanical Garden) from 1907 to 1912 under the editorship of A. A. Elenkin, then of I. A. Ol', and from 1923 to 1930 under the editorship of A. S. Bondartsev. After 1930 the journal ceased to be published.

Systematic reports on plant diseases, among them those caused by rust fungi, were published in the journal, "Ezhegodnye svedeniya o boleznyakh i povrezhdeniyakh kul'turnykh i dikorastushchikh poleznykh rastenii" (Monthly Reports on Diseases and Damaging of Cultivated Plants and Useful Wild Plants) edited by A. A. Jaczewski from 1903 to 1917.

The development of phytopathology after the October Revolution was characterized first of all by a considerable increase in the number of plant protection research departments and by an increase in the number of scientists. The number of published works is very high, the majority of them maintaining a high scientific standard and directed toward solving problems of protection against diseases, including the problem of resistance of the host plants and the pathogenic properties of the rust fungi.

Most of the investigations are concerned with rust of grain. The phytopathologist L. F. Rusakov (whose works span the period 1922—1938) was outstanding in the study of geographical distribution, species composition of rust fungi of grain, transmission of the infection, ecology, degree of harm they cause, and of many other problems. The present state of knowledge in the USSR concerning many of the problems listed on the rust of grain is

P.I.NAGORNYI

due to a great extent to the work of this investigator. Important work on the occurrence of infection in new districts and on other problems was carried out by A. Shitikova-Rusakova (whose works cover the period 1926—1949). Many articles, mainly popular-scientific, about the rust of grain were written by M. B. Gorlenko (from 1932 to 1951).

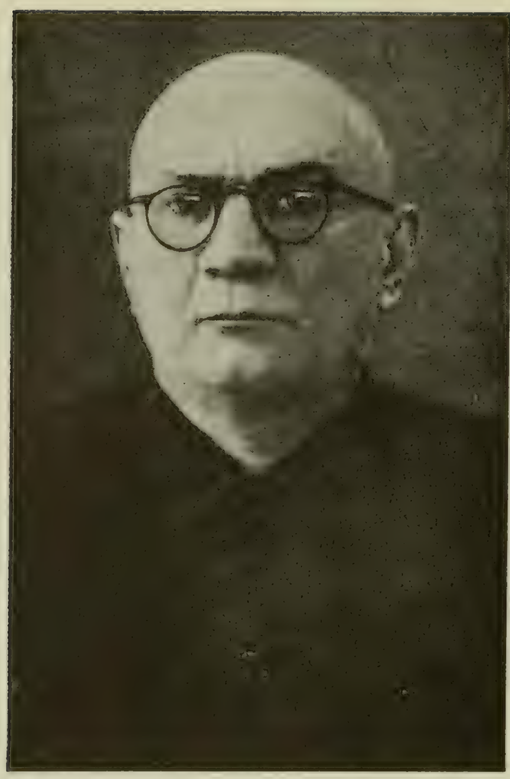
Works on different problems related to grain disease caused by the rust fungi were published by V. Aleksakhin (1924b), A. Eremeeva (1926), S. Grushev (1930, 1933a, 1933b), A. Prisyazhnyuk (1931, 1951, etc.), A. Boevskii (1933a, 1933b, 1936a, 1936b), E. Kotova (1935, 1938), G. Fridrikhson (1937), L. Pronicheva (1937, 1939, etc.), A. Bukhgeim (1937, etc.), V. Bryzgalova (1937a, etc.), I. Beilin (1938a, etc.), A. Marland (1937), K. Murashkinskii (1939, etc.), R. Strakhov (1938, etc.), M. Mkhitaryan (1940, 1948, etc.), I. Gvritishvili (1949), S. Kochkin (1949), A. Chumakov (1950), N. Lavrov (1951a, 1951b), L. Vasil'eva (1953), and others.

The monograph by N. Naumov, "Rzhavchina khlebnykh zlakov SSSR" (The Rust of Grain Crops in the USSR), (1939), correlates many of these works. The book presents recent data from literature on the rust fungi of grain; data on the biology, ecology, specialization, degree of damage, and prevention measures are included. The data of foreign investigators are extensively used. There is little on the history of the study of rust fungi in the USSR. This is compensated by the list of Russian works published in this century.

Apart from works devoted to the rust of grain, a number of review
25 articles and notes were published in which data are given on species composition and distribution of the rust fungi on other cultivated or wild plants. Among these works, mention should be made of the detailed article of P. Estifeev (1927) on diseases of cultivated and wild plants of Central Asia, the articles of S. Shembel' (1923, etc.) on diseases of cultivated plants in Astrakhan Region, of M. Alimbekova (1948) for Gorkii Region, of I. Abramov (1928) and A. Chumakov (1952) for the Far Eastern Territory, of K. Benua (1926, 1929) for Yakutia, of B. Roters (1927b) and G. Artemev (1935) for the Sochi District, of P. Nagornyi (1916a, 1926b) and B. Morozov (1928, 1929) for Stavropol Territory, of P. Nagornyi and E. Eristavi (1929) for Abkhazia, of D. Teterevnikova-Babayan (1952) and of D. Teterevnikova-Babayan and A. Babayan (1949) for the Armenian SSR, of E. Fomin and R. Ryss (1950) for the Ukrainian SSR, of P. Golovin (1950b) for Central Asia, of V. Sovzdarg (1954) for the central belt of the USSR, and reviews of other authors.

It is impossible not to mention the investigations on rust of kok-saghyz and of other rubber plants. The greatest number of works on this subject was published by N. Cheremisinov (1940—1951b), who carried out artificial infection with urediospores of **Puccinia taraxaci** Plowr.; according to Cheremisov, kok-saghyz is parasitized by a specific biological form which differs in some morphological features. A. Zaitseva (1947, 1948), who also carried out artificial infections, came to a similar conclusion; but she considers that it is possible to isolate the specific form, f. sp. **kok-saghyz** Works on the rust of kok-saghyz and other rubber plants were published by T. Nikolaeva (1933), E. Ezerskaya (1949), and M. Alimbekova (1950).

Other industrial crops were dealt with in the works of A. Tropova (1928), V. Rashevskaya (1928), I. Beilin (1929), V. Verhovs'kyi (1929), V. Tranzschel, L. Gutner and M. Khokhryakov (1933), W. Schmidt (1933), M. Zerova (1933), M. Rodigin (1939), M. Ermolaev and T. Popova (1953), and other authors.



N.G. ZAPROMETOV

Rust fungi on clover and lucerne were described in the works of I. Lobik (1915), B. Karakulin (1921), M. Utkin (1924), N. Trusova (1925, 1933), L. Arkhangel'skaya (1939), I. Egorova (1940), M. Lopatin (1949), L. Pronicheva
26 (1949a), D. Teterevnikova-Babayan (1950b), D. Teterevnikova-Babayan, N. Kechek and T. Stepanyan (1950), D. Teterevnikova-Babayan and D. Melik-Khachatryan (1953), M. Karimov (1953), K. Sergeeva (1953), V. Kuprewicz (1954), and in the works of many other authors.

After the October Revolution a great number of large-scale phytopathologic works were published which to a certain extent summarized the accumulated data on rust fungi. Some of these works have already been mentioned. Among other works mention should be made of "Kurs fitopatologii" (Course in Phytopathology) (1923, and subsequent editions; the 1952 edition — "Bolezni sel'skokhozyaistvennykh rastenii" (Diseases of Agricultural Plants)) by N. Naumov, "Bolezni sadovykh i ovoshchnykh rastenii s osnovami obshchei fitopatologii" (Diseases of Garden Plants and Vegetables, and the Fundamentals of General Phytopathology) (1934) and "Metody mikologicheskikh i fitopatologicheskikh issledovanii" (Methods of Mycological and Phytopathologic Research) (1932, 1937) by the same

author, "Gribnye i bakterial'nye bolezni sel'skokhozyaistvennykh rastenii" (Fungal and Bacterial Diseases of Agricultural Plants) (1922) by N. Voronikhin, "Spravochnik fitopatologicheskikh nablyudenii" (Manual of Phytopathologic Observations) (1930) by A. Jaczewski, "Promezhutochnye khozyaeva rzhavchiny khlebov i ikh rasprostranenie v SSSR" (Intermediate Hosts of the Rust of Grain and their Distribution in the USSR) (1934) by V. Tranzschel, "Zadachi i metody izucheniya boleznei sel'skokhozyaistvennykh rastenii" (Problems and Methods of Investigation of the Diseases of Agricultural Plants) (1935, written in the Belorussian language) by V. Kuprewicz, "Rzhavchina zernovykh kul'tur" (The Rust of Grain Crops) (1939) by L. Pronicheva, "Osnovy zashchity sel'skokhozyaistvennykh rastenii ot vreditelei i boleznei" (Fundamentals of the Protection of Agricultural Plants against Pests and Diseases) (parts I and II, 1936) by Boldyrev, Bukhgeim, Popov, and others, "Bor'ba s vreditelyami i boleznyami sel'skokhozyaistvennykh rastenii" (The Control of Pests and Disease in Agricultural Plants) (1949) by A. Megalov, and a number of other works. The data in the publications listed are based on literature; new original data are contained only in the listed work of V. Tranzschel.

In recent years a number of large works have been devoted to diseases of forest species widely used in the formation of field-protective forest strips. The largest such works are: the book of D. Sokolov "Vrediteli i bolezni polezashchitnykh lesnykh nasazhdenii i mery bor'by s nimi" (Pests and Diseases of Field-Protective Forest Plantings and Measures for Controlling them) (1950), the brochures of A. Prisyazhnyuk (1949a) and I. Brezhnev (1950), and other popular-scientific publications.

Some of the published popular brochures contain serious errors and inaccuracies. Thus, in the brochure of V. Ivanov, "Koronchataya rzhavchina ovsa i kak s nei borot'sya" (Crown Rust of Oats and How to Control it) (1948) it is indicated that the aeciospores of **Puccinia coronifera** affect only oats, while it is known that this fungus affects a large number of grains including oats. But, as was already mentioned, most of the work carried out by the phytopathologists and mycologists of scientific institutions and colleges is characterized by its high scientific standard as well as by its application to the solution of practical problems.

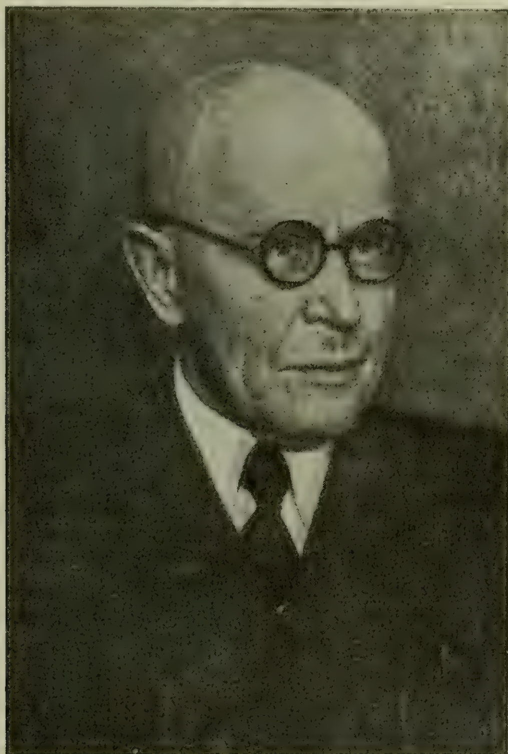
CYTOLOGICAL INVESTIGATIONS

Cytologic investigations of rust fungi in the USSR have been carried out for many years, beginning with those of the famous mycologist L. I. Kursanov in 1908. At the 12th meeting of Russian naturalists and physicians, Kursanov reported his investigations on the development of **Melampsora** on **Euphoria gerardiana** (1910), and indicated the presence of mononuclear and binuclear mycelium in the formation of uredia. L. I. Kursanov came to the conclusion that the absence of mononuclear mycelium in the formation of uredium cannot be considered as proof of the presence of aecia in the growth cycle of the fungus.

In his master's thesis, "Morfologicheskie i tsitologicheskie issledovaniya
27 v gruppe **Uredineae**" (Morphological and Cytological Investigations into the
Group **Uredineae**) (1915) and in his other works (1914, 1916, 1923, 1936)

L. I. KURSANOV

Kursanov presented the details of the cytological pattern in the life cycle of many (over 30 species) of rust fungi. In these investigations the origin of individual forms of sporophores and the genetic relation between them was determined for the first time.



A. S. BONDARTSEV

Much attention was given by L. I. Kursanov to the problems of reproduction of rust fungi. His investigations brought him to the conclusion that no true sexual process exists in rust fungi; the reproductive process is primitive and is carried out by the cells of the haploid mycelium.

The investigations of L. I. Kursanov still provide the only USSR source for comparative characterization of the history of development of aecial sporophores Aecidium, Caeoma, Peridermium, Roestelia, and Endophyllum. The investigations contain original data on cytology of the primary sporophores in a number of rust fungi with a reduced life cycle.

BIOLOGICAL INVESTIGATIONS

The first large investigation on the morphology and biology of rust fungi in Russia was undertaken in 1869—1871 by the founder of Russian mycology,

Academician M. S. Voronin, who traced the life cycle of the rust of sunflower — **Puccinia helianthi** Schw. With the help of many artificial infections, in which he used besides **P. helianthi** also **Puccinia suaveolens** (Pers.) Rostr. and other species parasitizing on the family **Compositae**, M. S. Voronin has shown the high degree of specialization of rust fungi. By his extended investigations M. S. Voronin has laid a foundation for the biological investigations in Russia.

The method of studying the life cycle and the relation between the rust fungi by means of artificial infections was bought into large-scale use in Russia by Voronin's closest student — the famous mycologist V. G. Tranzschel. His investigations continued, with short intervals, for about 50 years (from 1893 to 1942 — the year of his death). These investigations determined the change of hosts and the genetic relation for the multiple forms and species of rust fungi. Thus, in one of Tranzschel's first publica-
28 tions (1903) the genetic relation between the following fungi was proved: **Aecidium leucospermum** D. C. on **Anemone** and **Ochropsora sorbi** Diet. on **Sorbus aucuparia**, **Puccinia polygoni amphibii** Pers. on **Polygonum** and **Aecidium sanguinolentum** Lindr. on **Geranium**, **Aecidium trientalis** Tranz. on **Trientalis** and **Puccinia caricis** Schroet. on **Carex**. In subsequent works Tranzschel proved experimentally that the rust fungi are heteroecious and determined the aecial hosts of 35—40 species of rust fungi; host plant specialization of a large number of species was studied.

Of outstanding value was the "method of prediction," published by V. Tranzschel in 1904, on the biological properties of the heteroecious species of rust fungi; this was later named "Tranzschel's law." Tranzschel's method or law makes it possible, on the basis of a preliminary morphological examination, to establish the previously unknown aecial host for the heteroecious rust fungus. Moreover, Tranzschel's method makes it possible to foresee the existence of new species, including their biological and morphological properties (see p. 87).

Numerous artificial infections with rust fungi were carried out by O. Treboux (between 1911 and 1914). His experiments verified the genetic relation between different forms of sporophores in a number of heteroecious rust fungi, in particular in **Uromyces festucae**, Syd., **U. astragali** Opiz., and **U. genistae-tinctoriae** Pers. Treboux's experiments for clarification of the species composition of the host plants for **Puccinia coronifera** Kleb. and for a number of other rust fungi were particularly extensive and numerous. O. Tréboux usually carried out his experiments in natural conditions without isolation of the experimental plants. Therefore his results did not seem to be sufficiently convincing and aroused the suspicion of V. Tranzschel and several other mycologists. It is known, however, that O. Treboux in his experiments attempted to follow V. Tranzschel and G. Klebahn, who also drew correct conclusions on the biology of rust fungi on the basis of observations and experiments performed in the field.

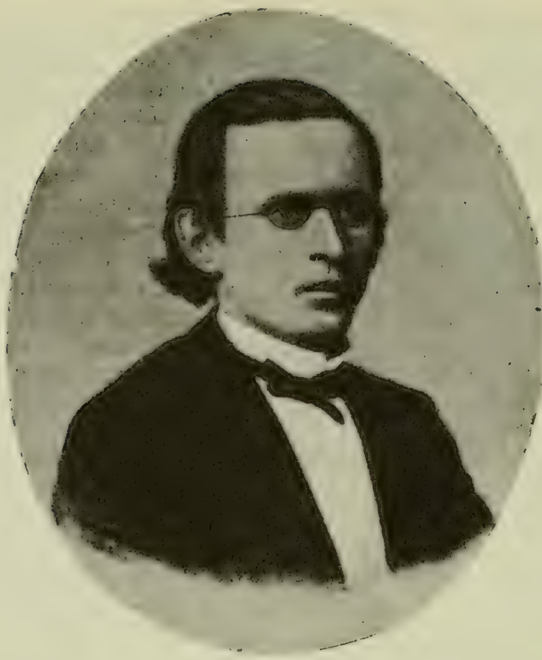
Among works concerned with these problems, mention should be made of the interesting observations of the little known investigator S. Dmitriev (1914) who determined the biological properties and the change of hosts in a number of rust fungi, and also the investigations of A. Bukhgeim on the biology of **Melampsora lini** (Schum.) Desm. A number of biological works, mainly on the rust of grains, are listed in the review of phytopathologic investigations.

After the October Revolution the biological investigations were successfully continued by V. Tranzschel; some of these investigations were published in articles and memoranda in various journals, while others remained unpublished. Most of the biological investigations carried out in the latter period by V. Tranzschel were published in his "Conspectus Uredinales URSS" (1939). Special attention should be given to his observations on rust fungi of the Far East and on numerous artificial infections carried out in order to determine the species composition of the host plants of Puccinia isiacae (Thüm.) Wint., P. opizii Bub., P. aeluropodis Rick., P. pygmaea Erikss., and P. cynodontis Desm.

Many recent biological investigations have been directed toward clarification of intraspecific differences, the manner of overwintering, and the spreading of the infection; also studied were the damage caused by the diseases and the interrelation between the host plant and the parasite, problems of immunity and methods of combating rust fungi that affect valuable agricultural plants.

29 Mention should also be made of A. Bukhgeim's investigation of the biology of Uromyces pisi (Pers.) Schroet. (1922) and Uromyces primulae Fuck. (1923), and of E. Eremeeva's observations on the life cycle of Puccinia triticina Erikss. (1924), which enabled more accurate definition of the range of the host plants for the aecial stage of the fungi. Other works include those of K. Murashkinskii on the rust of oats (1911) and rust of sunflower (1935), the works of N. Naumova (1937) who studied the effect of ecological conditions on the incubation period, of K. Stepanov (1940a, 1940b), Markhaseva and V. Sidorenko (1953) on the effect of external conditions on the development of uredia in rust fungi of grain, the investigation of A. Shitikova-Rusakova (1926, 1928, 1932a), K. Samutsevich (1931) and K. Stepanov (1935) on the distribution of spores of rust fungi by airstreams. Interesting observations on the effect of external conditions on the incidence of infection appear in the work of P. Saburova (1946). New data on the biological properties of rust of grain in the Far East are presented by L. Vasil'ev (1951). V. Bryzgalov (1935a, 1937a) has experimentally established the role of Thalictrum and especially of Leptopyrum fumarioides L. (Isopyrum fumarioides L.) as intermediate hosts of Puccinia triticina Erikss. for East Siberia; of considerable interest is the study by the same author (1951) of the manner of overwintering of Puccinia graminis Pers. f. sp. secalis Erikss. et Henn., which shows that the rust fungus can overwinter in the form of a mycelium in the rhizome of couch grass.

Extensive experimental work, including artificial cultivation of the fungi, was carried out by R. Kon'kova (1940) on Puccinia graminis Pers., by V. Lopatin (1935) on Uromyces striatus Schroet., by N. Cheremisinov (1941) and I. Zaitseva (1947, 1948) on the rust of kok-saghyz — Puccinia taraxaci (Rebent.) Plowr., by L. Pronicheva (1949b) on the rust of wheat grass — Puccinia persistens Plowr., by A. Pivkina (1951) on P. graminis Pers. f. sp. tritici Erikss. et Henn. Z. Azbukina (1952a—1952d) studied by means of artificial infections the range of host plants of Puccinia poae-sudeticae Jørst. and of several other species in the Far East; previously unknown host plants were established; the same author published observations on the overwintering of the rust fungi in the form of urediospores. M. Karimov
30 (1953) proved experimentally the strict confinement of Uromyces striatus Schroet. to the species of Medicago. By artificial inoculation M. Nikolaeva (1953) established a fairly narrow specialization of Uromyces onobrychidis (Desm.) Lév.



S.M.ROZANOV

Experiments with germinating spores of rust fungi were carried out in order to determine the type of action of the host plant in the initial phases of the infection. K. Sergeeva (1942) and V. Kuprewicz (1947) established the inhibiting action of aqueous extracts from tissues immune to plant parasites. In a number of cases the spores were destroyed in the presence of aqueous extracts from leaves of unusual hosts. In the experiments of V. Zemit (1947), seeds of different kinds of flax were germinated in water extracts from tissues infected by Melampsora lini-usitatissimi. The seeds of the resistant kinds germinated, but those of the sensitive kind did not germinate. The author recommends using the method of seed germination in aqueous extracts from affected tissues of vegetative organs to determine the resistance of the kinds of common flax to rust fungi.

In our investigations (Kuprewicz, 1940, 1945, 1947) the enzymatic action of rust fungi on substrates was established. As shown by many experiments, enzymatic activity in rust fungi and in other obligate parasites is considerably less than in saprophytes and in facultative parasites. Many extracellular enzymes common to saprophytic fungi were not found in germinating spores of rust fungi.

A large number of works has been devoted to study of the racial composition of the rust fungi. Thus, investigations of the racial composition of Puccinia graminis Pers. were carried out by D. Teterevnikova-Babayan (1926, 1928), by A. Barmenkov (1939), and by some other authors. More numerous were the works on the racial composition of brown leaf rust of wheat, Puccinia triticina Erikss.; A. Bukhgeim and M. Lisitsina (1934) investigated the racial composition of P. triticina in the central districts of

the European part of the USSR; A. Barmenkov (1935, 1937b, 1939) investigated the geographical distribution in the USSR, E. Geshele (1936) the racial composition of rust fungi in the Odessa area; V. Rachevskaya and A. Barmenkov (1936a, 1936b) and V. Rashevskaya (1937) investigated racial composition of the same species. Other review articles are those of L. Pronicheva (1938) and E. Goryacheva (1937, 1949), who studied the ecological properties of the physiological races of P. triticina of different geographical origin, of T. Fedotova (1936, 1939), who developed a method for determination of wheat varieties resistant to rust in the presence of races having a different infectivity, and of V. Markhaseva (1937), who studied the mutability of the infectivity of the races.

TABLE 1. Change in the infectivity of **P. triticina** on cultivation of the parasite on different wheat varieties

Infection variant	Infection incidence of the varieties[1] (in points on a scale)							
	Loros	Karina	Brevit	Gussar	Vebster	Malakhov	Demokrat	Mediterraneum
Initial monosporous culture of the fungus .	2	0–1	0	1	0–1	0	0	0
The same culture after 5th generation on the variety:[1]								
Zemka	2	1	2	1	0–1	3	4	2
Krasnodarka	3	1–2	2–3	1–2	2–3	4	2–3	1–2
Markiz	0–1	1	1–2	2	2–3	0	2–3	2

[1] [Names of the varieties are transliterated from the Russian original.]

31 A thorough investigation on mutation problems was carried out by A. Mamontova (1935). Numerous experiments carried out by this author have convincingly shown that Puccinia triticina is capable of changing its infective properties when parasitizing on wheat varieties that are immunologically different. A table taken from the work of A. Mamontova is presented by way of illustration (Table 1). The data of the investigation testify to the changes in the specialization of the parasite brought about by long cultivation on a certain variety.

Work on the racial composition of the rust of grain in selected geographical districts of the USSR was carried out: by M. Gorlenko (1936b) in Voronezh Region, by N. Petrushova (1937) in Leningrad Region, by M. Egorova (1939) and G. Pustovoit (1949) in Krasnodar Territory, by Z. Chernetskaya (1941) in the North Ossetian ASSR. I. Beilin (1949) and M. Khokhryakov (1951) published review articles on the specialization of rust fungi in various districts of the USSR. The same problem is treated in a chapter in the monograph of N. Naumov (1939).

The study of the ultra-narrow specialization of the rust fungi as developed by Stakman (1914) and several other, mainly American authors is based on the discovery of the intraspecific specialization in rust fungi and in some other fungi (Klebahn, Arthur, Tranzschel, and others). This study stimulated a number of investigations, some of which are listed above.

N. I. VAVILOV

These works discuss specialization of the fungus to a variety, seldom to varieties of a certain culture, i. e., they discuss the intraspecific diversity of infectivity of the parasite applicable to intraspecific morphological and biochemical diversity of the host plant. The characteristic biological properties of the parasite often depend not only on the variety on which the fungus parasitizes but also on the geographical location of the variety.

D. N. TETEREVNIKOVA-BABAYAN

Physiological races (or biotypes) are taxonomically subordinated to special forms into which species are broken down and which, by analogy with the higher plants, are forms of existence of the species, simultaneously with the initial stages of intraspecific physiological and morphological
32 differentiation.

Every physiological race of the rust fungi, as testified by facts accumulated in a great number of works, is characterized by the capacity or potentiality to infect any variety or even many varieties that compose a certain species of the host plant; however, infectivity changes in dependence on the kind of host or the diversity of the host. The adaptation of a physiological race to a kind of host or to diversity of the host plant is not absolute but always relative. Moreover, there are physiological races which are capable, to varying degrees, of parasitizing also on many species closely

related to the main host plant. There are also rust fungi characterized by a wide polyphagy, as for example Puccinia graminis Pers., P. isiacae (Thüm.) Wint., P. cynodontis Desm., which are capable at one or another stage of their development of parasitizing on a great many species of host plants. This, of course, does not mean that the rust fungi mentioned may infect any plant. The range of host plants for these species is limited.

The impression is received that the most important purpose in studying the racial composition of the parasite, viz., protection of the crop from damage, has never been completely achieved, and that if it has been achieved then the effectivity has been transitory. The conclusions from the investigations on physiological races and their properties have often complicated the work of breeders, obliging them to aim for resistance of the variety to a certain physiological race and not for resistance to the parasite species as a whole. Resistance to a physiological race of the parasite often resulted in the new resistant variety being attacked, sometimes in the first few years, by a new physiological race (see, for example: Zemit, 1949; Mamontov, 1952; Mkhitaryan, 1952).

The amplitude of infective change in the progeny of a physiological race which is highly adapted for parasitizing on a certain variety includes the infectivity of any physiological race (or biotype) into which the particular form can break up.

Differences in infectivity among the progeny are mainly quantitative, for example, the number of urediospores capable of causing infection in different varieties will be different, but in the presence of a sufficiently high number of spores will cause infection (see the works of V. Rashevskaya, V. Markhaseva, A. Mamontova, and also Stakman et al., 1914–1935).

Data obtained by investigation of the racial composition (or biotypes) of special forms of rust fungi testify to the presence of varying infectivity correlated with specific conditions of parasitism on different kinds or varieties which are distinguished by physiological, biochemical, or anatomical differences. The accumulated data should discourage the drawing of hasty conclusions when testing the resistance to infection of newly developed varieties of cultivated plants.

33 THE EFFECT OF RUST FUNGI ON HOST PLANTS; RESISTANCE TO INFECTION; CONTROL MEASURES

The effects of rust fungi on the physiological processes of the host plant were studied by a number of authors (Kokin and Tumarinson, 1934a, 1934b; Kuprewicz, 1934, 1947; Sukhorukov, 1936). Infection has an unfavorable effect on photosynthesis, respiration, and transpiration of the host plant. The formation of pigments (chlorophyll, carotenoids) is noticeably suppressed by the parasite, the amount of carbohydrate reserves (starch, sugar) in tissues of injured plants decreases, and the activity of a number of enzymes is disturbed. Disturbance of the physiological processes of the host plant usually leads to a considerable decrease in the intensity of organic matter accumulation and to a decrease in yield. Acute disease of the grain can cause a reduction in yield of 70–80%.

Much attention has been directed to the study of immunity of cultivated plants to rust fungi. In the widely known works on immunity by N. I. Vavilov

(1913a, 1913b, 1919, 1935, 1935–1936, 1939), data of both local and foreign authors are discussed in detail and correlated. Vavilov, like many other investigators and in particular Jaczewski, came to the conclusion that the selection of resistant varieties was of the utmost importance as a basic method of controlling the rust fungi. The work carried out by breeders in the last three decades has justified this approach. The losses in yield caused by rust fungi and other parasitic fungi have greatly decreased, though they are still considerable.

The question of the resistance of various crops to rust fungi and the question of selection of resistant varieties were dealt with in the works of N. Litvinov (1912), K. Renard (1927), P. Luk'yanenko (1934, 1935, 1941), V. Bryzgalova (1935), V. Gulkanyan (1936, 1938, 1947), Shcherbak (1937), V. Zolotnitskii (1938, 1939), E. Geshele (1938, 1939, 1941), S. Syrovatskii (1938, 1939), V. Gulkanyan and S. Oganesyan (1942), G. Levkovskaya (1948), M. Mkhitaryan (1949), V. Zemit (1949), P. Chesnokov (1949), Z. Chizhevskaya (1949), F. Shevchenko (1950a, 1950b, 1951), A. Anpilogov (1951), N. Voitchishin
34 (1952), A. Mamontova (1953), the works of the Kharkov State Selection Station (Selektsiya zernovykh kul'tur . . . (Selection of Grain Crops . . .), 1947), and many others.

L. F. RUSAKOV

Attempts have been made to relate the immunity or high resistance of plants to their anatomical, physiological, biochemical and other properties. The following factors were considered: the development of waxy coatings on leaves, the thickness of the cuticle, the behavior of the ostial system, the degree of pubescence, the presence of any compounds in the cell sap, etc.

N. Kargopolova (1936, 1937) indicated the relation of the resistance of plants to the presence of phenol compounds in their tissues; similar relation was also reported in foreign literature. The relation between resistance to infection and an active acidity of the cell sap has also been noted (Tropova, 1929). Concerning rust fungi, these data, both local and foreign, do not permit the establishment of any relation. A relation is indicated between the plant's susceptibility to obligate parasites and the activity of their oxidizing enzymes – catalase, peroxidase, and tyrosinase (Sukhorukov, 1938, 1952; Nilova and Egorova, 1948; Nilova, Svoiskaya and Ikonnikova, 1948; Rashevskaya and Nilova, 1952; Nilova and Rashevskaya, 1954). With increased activity of these enzymes, in particular of tyrosinase, the plant's susceptibility to rust increases. An increased tyrosine content characterizes resistant varieties.

According to our data (Kuprewicz, 1947), the resistance of oats varieties to **Puccinia coronifera** Kleb. is related to the activity of the bios in its tissues; a plant with a low activity of the bios will not be affected by rust. There are indications of a relation between the resistance (or the degree of affection by the rust), the physiological activity, and the growth phases (Dunin 1946; Zhuk, 1949; Romashenkov, 1951, 1953).

Experiments were carried out to transplant the embryo of a susceptible variety to the endosperm of a resistant variety. By this method, as it was reported by F. Shevchenko (1951) and by E. Fialkovskaya (1952), a form of wheat was developed that was resistant to **Puccinia graminis** Pers., **P. triticina** Erikss., and **P. glumarum** (Schm.) Erikss. et Henn.

A positive effect of a number of trace elements on the resistance of wheat against rust was found, as well as on the strengthening of the obtained resistance in the progeny (Strakhov and Yaroshenko, 1950; Nilova and Rashevskaya, 1950, 1952). Numerous observations and experiments are known to have indicated dependence of the infection intensity on agrotechnical procedures, in particular on the type of fertilization, sowing times, supplementary feeding, and in general on the combined effect of environmental conditions (Regel', 1910; Maklakova, 1936, 1937; N. Naumova, 1940, 1950; Dunin, 1946; Levkovskaya, 1948; Zemit, 1949; Shevchenko, 1950; Voitchishina, 1953, and others).

It was shown by F. Shevchenko (1950) and A. Shulyndin (1953) that the late fall sowing of spring crops in the phase of intergrown seeds in certain years produces new forms, very different from the initial. Among the newly developed forms A. Shulyndin found plants which produced progeny highly resistant to brown rust.

The results of selection of cultivated plants resistant to rust fungi and to other parasitic fungi have been highly satisfactory. The selection method is very effective. Of course, other ways and means of combating the parasitic fungi are possible. Thus, if there is a variety which is strongly
35 affected but which is distinguished by exceptional taste, good baking qualities, etc., the selection method for resistance of the particular variety may prove unacceptable. It is necessary to search for other ways of increasing resistance to infection. Among the newer methods, probably that of artificial

immunization will be of outstanding value in the near future (see, for example: Polyakov, 1949; Yarwood, 1954, pp. 374—377). The chemical methods of control by means of the latest fungicides are of great importance. In the meantime the practical value of biological methods of control remains unclear (Fedorinchik, 1952).

V.F.RASHEVSKAYA

The number of species of rust fungi found in the USSR reaches 1,000. They are more numerous here than in other countries (U. S. A., western Europe) which have complete lists of rust fungi. The great number of species discovered indicates the relatively high standard of mycological studies in the USSR. The number of species may possibly be even higher if the less well investigated territories are included — the mountain districts of the Central Asian republics, the Far East, and some northern districts of the European part of the USSR and Siberia.

While the morphology and species composition of the rust fungi have been comparatively well studied, much of the growth history and biology of these strictly obligate parasites remains unknown. There is a need for further investigation of the infectivity and of the host plants' range of a great number of rust fungi. Even for widely distributed and generally known species such as **Puccinia graminis** Pers., **P. coronata** Corda, **P. coronifera**

Kleb., and **P. triticina** Erikss., the known collection of host plants cannot be considered exhaustive or final. Thus, in the experiments of Z. Azbukina (1955) under artificial conditions, the urediospores of **Puccinia rangiferina** S. Ito caused an infection in hosts unusual for this fungus — wheat, barley, and oats. Further experiments on artificial infection are necessary.

Of great interest is the reaction of the resistant plants to implantation of infection: the affected tissue of these plants immediately dies off. The death of the tissue causes the destruction of the parasite — of the rust fungus, and the plant frees itself from infection. The mechanism of this reaction remains unknown. There is a need for further study of the means
36 of overwintering and of spring renewal of almost all the rust fungi that parasitize on grain, especially in the southern districts of the USSR and in the Far East. The causes of the formation of rust epiphytes remain unknown (Naumov, 1939). For example, for a number of years (from 1943 to 1946) we could not discover in the Kondara Ravine (Gissar Range, Tadzhik SSR) a certain widely distributed fungus, **Coleosporium datiscae** Tranz., which parasitizes on **Datisca**. A repeated thorough inspection of the vast overgrowth of **Datisca** in the ravine produced no positive results. However, when visiting the ravine a year later, i. e., in the following vegetational season, the overgrowth of **Datisca** over a large area appeared orange-red due to heavy affection of the plants with the indicated rust fungus. All the years of the investigation seemed to be similar in climatic conditions; this was verified from data of the local meteorological station. We could find no convincing explanation for the development of the epiphytes.

Further development in the investigation of intraspecific variability of the infective properties of the rust fungi is to be expected. The ways of development of the heteroecism, as well as the complex life cycle of the euform, remain completely unknown. The attempts to cultivate rust fungi on artificial culture media should be renewed.

Rust fungi possess the ability to respond to the most delicate physiological and biochemical properties which distinguish the species, the variants, and often the varieties of the host plants. In a number of cases this property was used to establish affinity between the higher plants (Tranzschel, 1927a, 1936a; ·Lashchevskaya, 1927; Kuprewicz, 1936). Elucidation of the mechanism, with its high degree of adaptability, of the rust fungi would be a valuable investment in the study of parasitism.

The successful development of the biological and ecological studies would increase the effectivity of the measures for prevention of the great losses caused every year by rust fungi in agriculture and forestry.

37 MORPHOLOGY, CLASSIFICATION, AND BIOLOGY OF UREDINALES

SPORE TYPES AND LIFE CYCLES OF RUST FUNGI (UREDINALES)

Rust fungi parasitize vascular plants. They are obligate parasites, i.e., unable to develop on dead substrates. Unlike most parasitic and especially semiparasitic fungi which attack primarily weak plants, the rust fungi invade, as a rule, healthy, well-fed plants, rarely weak ones.

Rust fungi are noteworthy for their pleomorphism, i.e., the diversity of spore types produced in the course of their life cycle. The different spore types indicate stages or phases of development. Although development of a certain kind of spore depends, as in the majority of other fungi, almost exclusively upon environmental conditions, the alternation of stages is fixed by heredity and is stable for each species, while the environmental conditions can only accelerate or delay the development of the subsequent stage. Some rust species develop all five stages, while the life cycle of other species involves only some part of them. In rust fungi with a complete cycle (macrocyclic) the following sequence of stages is observed: basidia — IV, spermagonia (pycnidia) — 0, aecia — I, uredia — II, and telia — III.

Each stage develops its characteristic spore form: basidiospores, spermatia, aeciospores, urediospores, and teliospores. The roman numerals accompanying the designations given above indicate the corresponding stage. These symbols are widely used as substitutes for the stage designation. All nondegenerated rust fungi have basidiospores, and therefore their symbol (IV) is rarely used. Thus, for example, 0, I, III indicate that the given species has spermagonia, aecia, and teliospores. The spermatia developing in the spermagonium, being the reproductive fertilizing cells cannot infect the plant; consequently, their symbol is often omitted when numerals are used to designate the developmental cycle of the fungus. The numerals are also used to indicate the stages in a given rust specimen. If one of the stages is weak the symbol is parenthesized; for example, II (III) infers that the teliospore is weak in the given specimen.

According to the stages or spore types involved in the cycle of development, rust fungi are designated as follows:

0, I, II, III — **Eu-Uredinales** (if spermagonia are absent the type will be **Cata-Uredinales**, according to Maire (1911)).[1]

38 0, II, III — **Brachy-Uredinales**.

II, III — **Hemi-Uredinales**. To this type are referred either forms with spermagonia or aecia still unknown, or else forms in which single

[1] The additional designation of developmental types proposed by Maire has not been widely adopted.

urediospores are present in the telium, as in **Uromyces ficariae**. Since the latter does not produce special uredia it should legitimately be referred to the type **Micro-Uredinales**.

0, I, III — **Opsi-Uredinales** (in the absence of spermagonia — **Catopsi-Uredinales**, according to Maire).

III — **Micro-Uredinales** (if spermagonia are present, **Hypo-Uredinales** according to Maire).

0, I — **Endo-Uredinales**. This type should not be confused with the aecia involved in the developmental cycle of **Eu-Uredinales** and **Opsi-Uredinales**. In **Endo-Uredinales** the aeciospores fulfill the role of teliospores, i. e., cells morphologically indistinguishable from aeciospores, giving rise to basidia and not to hyphae (Figure 1).

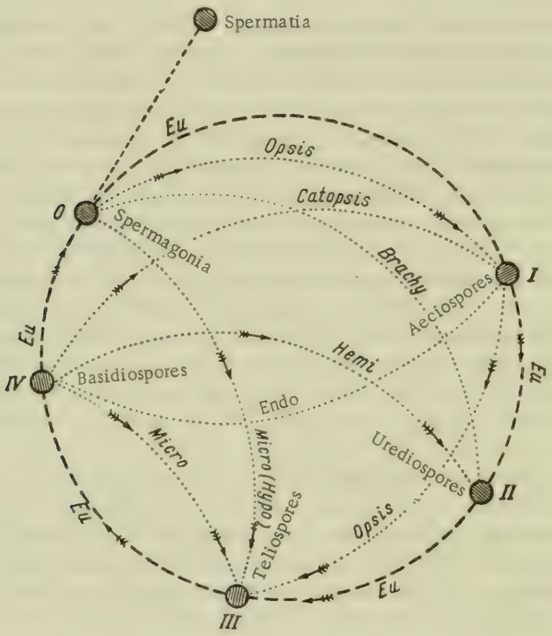


FIGURE 1. Diagram of developmental types of rust fungi

When the type of development of a given species is to be indicated, the word **Uredinales** is replaced by the corresponding generic designation, for example, **Puccinia suavolens** may be referred to the type **Brachy-Puccinia**. But when a species of the type **Opsi-Uredinales** is to be indicated, the suffix "opsis" is frequently added to the root of the generic designation, for example: **Uromycopsis**, **Pucciniopsis**, etc. The type **Lepto-Uredinales** was hitherto considered equivalent to **Micro-Uredinales**, comprising species that develop only teliospores, but distinguished from **Micro-Uredinales** by the germination of teliospores upon maturation, without a rest period. Since this type is distinguished by characteristics entirely different from the above-mentioned, and the teliospores' property of germinating without a rest period characterizes also species

39 which according to their developmental cycle belong to various other types, this property may be indicated by the word **Lepto** preceding the type designation, for example: **Lepto-Eu-Coleosporium, Lepto-Eu-Chrysomyxa, Lepto-Opsi-Gymnosporangium** (or **Lepto-Gymnosporangiopsis**), **Lepto-Micro-Puccinia**, etc.

In many rust species (spermagonia and) aecia develop on host plants entirely different from those of the other stages. Such species are known as heteroecious, and they are referred to the type **Hetero-Eu-Uredinales**, or **Hetero-Opsi-Uredinales**. Unlike heteroecious species the autoecious species pass through their whole life cycle on a single host species and are designated **Aut(o)-Eu-Uredinales**, for example, **Aut-Eu-Puccinia helianthi**.

In some rusts, as for example in **Uredo alpestris** on **Viola**, even the most thorough search failed to reveal teliospores. These types were designated by Maire (1911) **Pyro-Uredinales**. This is a temporary type, as it is hoped that somewhere even now the species referred to it develop teliospores. This type, derived apparently from autoecious species, has lost the property of producing teliospores either as a consequence of the impaired aecial growth, or for want of aecial hosts, or because of climatic conditions. Thus, **Puccinia obscura** on **Luzula**, in the northern USSR, subsists by developing numerous generations of urediospores, overwintering in the form of young uredia on the leaves that remain alive until spring.

In western Europe, where the growth season is longer, the fungus develops aecia on **Bellis**, in October and even later; in Leningrad, where **Bellis** is only a cultivated plant, the fungi cannot infect **Luzula** because of the late appearance of aecia. Reproducing continuously through urediospores the rust fungi lose, to a certain extent, the property of producing teliospores. Similar races exist, apparently, also among rusts that parasitize grain crops. Thus, in eastern Siberia, where **Berberis sibirica** occurs only on mountains, races of **Puccinia graminis** which hardly produce any teliospores have evolved; these overwinter in the uredial stage on winter rye and couch grass (observations reported by V. Bryzgalova).

The germinating spores penetrate through the stomata (in the American **Gymnoconia** the sprouts of aeciospores penetrate through the walls of epidermal cells), or through the outer walls of epidermal cells, as revealed in infections with basidiospores. The mycelium spreads almost exclusively in between the cells (intercellularly), ramifying into short branchlets inside the living cells, in the form of suckers or haustoria through which the nutrient substances are absorbed. The haustoria vary in shape — from small spherical bodies and elongate bags to ramified tangles which almost fill the nourishing cells. It has been reported that haustoria do not penetrate the plasma, but only push aside the plasmatic mass.

In the majority of cases the mycelium occupies a relatively small space around the site of fungal infiltration. Such an infection (including the mycelium) is known as local (localized). But frequently the mycelium runs through the entire shoot almost to its growing point; it is then known as diffuse, causing a diffuse infection of the plant. In the first case the infected site is often thickened as a consequence of tissue hypertrophy and acquires the appearance of a pale yellow or red patch, while sometimes no
40 patch whatever is noticeable. Spore production soon sets in at the infected site.

An intermediate position between the local and diffuse infection is occupied by the infection in which the mycelium spreads gradually. The mycelium of **Puccinia glumarum** grows for some time along the host's glumes, continuously producing uredia, finally arranged like beads on a string. The mycelium of the aecial stage of **Cronartium** in the branches and trunk of pine trees is perennial, and every year it occupies a new sector, inevitably situated below that of the preceding year. In diffuse infections the attacked shoot or its leaves frequently acquire an unusual — deformed — appearance. The infected shoot is usually longer than normal, the leaves smaller; in lobate leaves the lobes are smaller, usually shorter and wider. Diffuse infections, as known from personal observation, proceed as follows. The germinating spore infiltrates in the leaf the mycelium growing below the surface (so that no sign of infection is perceived from outside) until it reaches the buds of the next year's shoot; there it overwinters; with the onset of growth the mycelium grows with the shoot, infiltrating also in all leaves. While in local mycelium spore production starts with each unit or group formed, in the diffuse mycelium spore production is uniformly dispersed over the entire frond; the growth of the shoot only occasionally outstrips that of the mycelium, in which case the upper leaves of the infected shoot remain healthy and free of sporophores.

For the most part the diffuse mycelium is perennial, causing development of infected shoots with each growth season. In tree stands they often lead to enhanced growth of shoots and intensive branching; the tufted growth of the shoots resembles a broom and is known as witches' broom. With the infiltration of the sproutlets in plants related to the host, but unsuitable for the normal development of the fungus, patches appear on the leaves; infection by basidiospores occasionally gives rise to spermagonia as well, but, since mycelial development leads to the death of the tissue at the infected site (necrosis), its own death follows. Sometimes the tissue remains alive, and chlorotic pale patches or yellowish discolored spots appear on the leaves; on these patches sporophores either fail to develop or their development is weaker than normal. Obligate parasites develop adaptation to the host, since in extensively infected plants the tissues die, leading at the same time to the death of the mycelium. Such an adaptation is probably operating in infections of **Rumex** with the fungus **Uromyces rumicis**; the infected leaves retain the green coloration around the uredia in spite of the yellowed, late autumnal foliage.

As stated earlier, the rusts are endowed with a pronounced pleomorphism producing various spore types, or developmental stages (spermagonia, aecia, uredia, telia, and basidiospores).

SPERMAGONIA, as recently demonstrated but long ago presumed, represent the sexual organs in which the fertilizing cells — spermatia — develop. The term "spermagonium" was introduced by L. Tyulyan, in 1851, but later O. Bretfeld denied sexual processes in these fungi, replacing this term with "pycnidia," which turned out to be an unfortunate choice both from the biological and the morphological aspect. In ascomycetes pycnidia imply spherical formations open above with the conidia developing inside. In
41 **Uredinales** spherical spermagonia are encountered only among some **Pucciniaceae**, whereas in many species of the latter and in all **Melampsoraceae** the spermagonia are flat, open, resembling the sporophores of

Melanconiales. J. Arthur added to "pycnidia" the term "pycnia." Since the sexual nature of spermatia has been proved, the more appropriate term "spermagonia" should be reestablished.

Spermagonia are rather varied in structure (Figure 2). The simplest type is found in genera of **Melampsoraceae**. Under the cuticle, over the epidermal cells are found the unicellular spermatiophores. These are vertically arranged rather long and thin cells constricted at their tips like beads into small globoid or ovoid spermatia. Spermagonia with a flat layer are also found in many **Pucciniaceae**, but in **Puccinia**, **Uromyces**, and **Gymnosporangium** the spermagonia are globoid or flask-shaped with the spermatophores radially arranged over the entire inner surface, with paraphyses projecting from the ostiole (periphyses, ostiolar filaments) (Figure 3). In the genus **Gymnosporangium** the spermagonia (hemispherical at the bottom owing to the slight centripetal slope of the spermatiophores) also have ostiolar filaments. In **Leucotelium**, **Tranzschelia**, and **Ochropsora** the spermagonia are flat at the bottom with a conical peridium, opening at the apex, with projecting paraphyses. In most genera of **Melampsoraceae** the spermagonia are flat, or — rarely — somewhat spherical. In species of **Cronartium**, flat spermagonia without paraphyses develop under the cortex of pine branches. In the majority of genera with flat spermagonia the latter are subcuticular, rarely subepidermal; spherical spermagonia are immersed in the mesophyll.

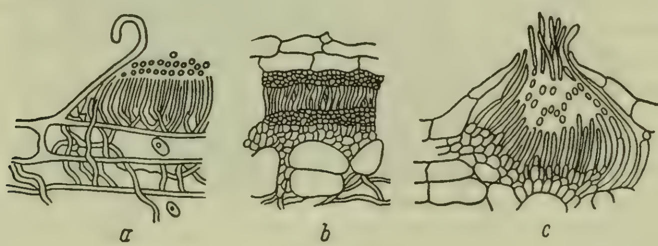


FIGURE 2. Spermagonia:

a — subcuticular, in **Pucciniastrum**; b — under the bark, in **Cronartium**; c — subepidermal, in **Gymnosporangium**. (After Arthur, 1929.)

The spermagonia secrete a sweet, fragrant, thick fluid sought by insects which transport the spermatia and are thus instrumental in the reproductive process. Spermagonia are always produced on the mycelium arising from the germinating basidiospores, and precede, in the life cycle of the fungus, the aecia (in **Eu-Uredinales** and **Opsi-Uredinales**), the uredia (in **Brachy-Uredinales**), and the telia (in **Micro-Uredinales**). In **Opsi-Uredinales** with repeating aecia the spermagonium precedes only the first generation. Development of spermagonia is suppressed in many rust fungi, especially those of the **Micro-Uredinales** type.

AECIA. The aecial stage implies the growth of sporophores on the mycelium formed by basidiospores, in which the spores — aeciospores — develop in series, subsequently breaking up into individual spores. In
42 the genera **Coleosporium** and **Chrysomyxa** urediospores also develop in series, but in these genera the uredia are produced from aeciospores devoid of the distinct peridium characteristic of the aecial stage. In some

Opsi-Uredinales repeating aecia may develop on the mycelium formed by aeciospores, whereupon the secondary aecia, as stated earlier, are not preceded by spermagonia. More often than not infection with aeciospores does not give rise to a new generation of aecia.

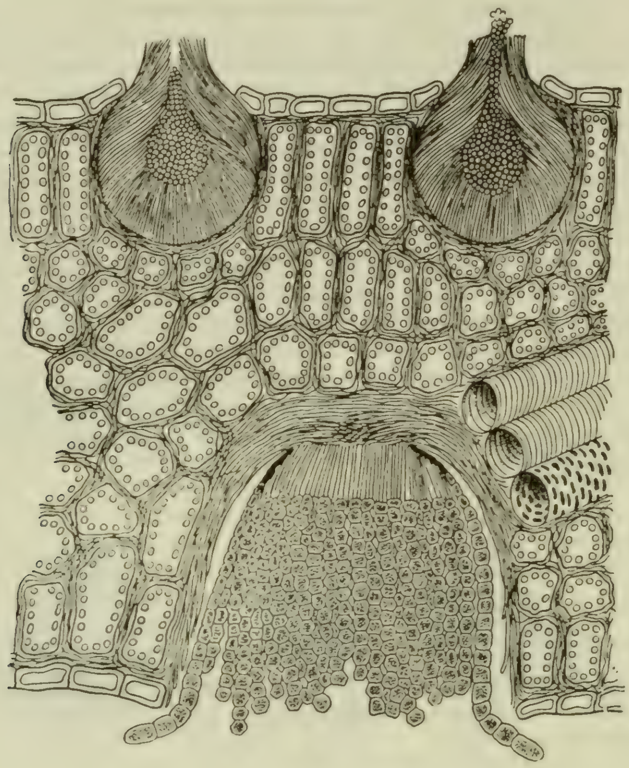


FIGURE 3. Spermagonia and aecia of **Puccinia graminis**

Arthur applied the term aecium to all sporophores arising from gametophytic (haploid) mycelia developing from basidiospores, irrespective of the morphology of the sporophore; thus he designated even the primary uredia in **Brachy-Uredinales** "stylosporous" or "uredinoid" aecia.

In the true or cup-shaped aecia the rows of spores are surrounded initially on the sides and on top by a cover, the peridium or pseudoperidium. The peridial roof develops from the first apical cells of the first spore-forming rows, the lateral walls being built of modified cells of the external rows, homologous with the spores in the inner rows. Embedded in the form of spherical bodies in the plant tissue, the aecia subsequently emerge, their peridium tearing at the apex and allowing the aeciospores to scatter.

In the species of **Puccinia**, **Uromyces**, and other genera (**Ochropsora**) the peridium usually ruptures at the indented margin which is fre-
43 quently more or less flexed to the outside. In **Tranzschelia** and **Leucotelium** the peridium ruptures into several lobes (3 — 5). The

peridium grows longitudinally from the base, concomitantly with the increasing number of aeciospores in the rows. If the aecia develop in calm and dry air their peridium extends into a rather long cylindrical tube; this can be seen on aecia grown indoors, or in the dry southern regions of the USSR; usually the peridium continues to extend. In species of the genus **Gymnosporangium** (with the aecia formerly referred to a special genus — **Roestelia**), the peridium grows either normally into a longitudinal continuous tube, or elongates, breaking up into individual rows of cells, or remains closed at the apex and ruptures at the sides into narrow strips.

In the majority of aecia of conifer rusts, especially of the genera **Cronartium** and **Coleosporium**, the vesicular peridium bursting irregularly relates these genera to the genus **Peridermium**. In some genera the aecial stage is devoid of peridia. In the genus **Phragmidium** the peridium is substituted by the paraphysis — a tuft of usually clavate bulging filaments. In the genera **Melampsora** and **Gymnoconia** the flat aecia, devoid of any cover, were formerly referred to the genus **Caeoma**; these may be designated caeomoid aecia. In the genus **Nothoravenelia** aecia are deeply sunken into the host tissue resembling true aecia but are devoid of a peridium. In some species the peridial cells are very loosely joined to each other and separate so easily that the peridium might be overlooked, as, for example, in **Uremyces lycoctoni**, **Puccinia cnici**, **P. chondrillae**, **P. laetucarum**, etc. Usually, the peridial cells are closely knit together so that the upper cells press onto the lower ones; the wall often bears a toothlike projection, directed downward. The outer and inner walls usually differ in thickness and sculpture.

Aeciospores are always unicellular, their wall rather densely verrucose; among the representatives of the USSR flora the spore wall is covered with loosely scattered scales or densely arranged platelets. Only in some species of the genus **Phragmidium** the wall of aeciospores has a peculiar structure — distinctly visible in those developing on conifers and formerly referred to the genus **Peridermium**. The matrix of the spore wall appears to be filled with small rods imparting a striated appearance to the cross section, whereas the surface is punctate-verruculose. A similar structure is revealed in the peridial wall of the aecia.

In the majority of rust fungi aeciospores have no pores. In species of the genus **Gymnosporangium** and in some species of **Puccinia** with brownish walls the pore is quite distinct; in some species of **Phragmidium** the pore becomes visible only after soaking the spores in water.

The wall of the aeciospore is usually colorless, occasionally brownish, and in species of **Gymnosporangium** — dark brown.

In the extremely detailed description of the spore wall Klebahn indicated the presence of large warts in the midst of smaller ones, in many species. It is possible that with these larger warts are associated the conspicuous, rather large shiny globules found on the spore wall, which are later shed, leaving depressions on the spore wall. A list of the fungi in which these globules have been observed falling out of the wall was prepared by Klebahn. According to Dodge similar bodies are instrumental in the ejection of aeciospores after the elastic straightening of the minute aeciospores, initially immersed into the wall structure. The contents of peridial cells

44 are usually colorless, whereas the contents of aeciospores are usually reddish orange in color, except for species, and even entire genera, in which the contents are colorless, and the aecia appear white, as in **Uredinopsis**, **Milesia**, and **Ochropsora**. Equally colorless contents but faintly stained walls characterize the aecia of **Tranzschelia**, **Leucotelium**, and **Nothoravenelia**.

The aeciospores germinate, in the majority of cases, soon after their maturation. Only the aeciospores of certain species of **Gymnosporangium** have been reported to germinate after a winter rest. Vegetative hyphae shoot up from the aeciospore, infiltrating in the plant through the stomata.

UREDIOSPORES, like aeciospores, are always unicellular. In most genera single urediospores are produced at the tip of hyphae, which usually resemble more or less elongate pedicels; in the majority of **Melampsoraceae** no pedicels were noticed. The pedicels remain long after the urediospores have been shed, which has led some authors to describe them as paraphyses, but new urediospores do not develop on them. Beaded chains of urediospores resembling aeciospores are produced only in the genera **Chrysomyxa** and **Coleosporium**.

The wall of the urediospore is either colorless (in all **Melampsoraceae** and some **Pucciniaceae** of the USSR) or stained yellowish or even dark brown. Perfectly smooth urediospores are known only in the genera **Milesia** and **Uredinopsis**; usually urediospores have a densely verrucose or, more often, a sparsely echinulate wall. The urediospores of **Puccinia oblongata** appear to be smooth, but Klebahn succeeded in revealing some spinules on these too. In the genus **Uredinopsis** many species produce in the first generation smooth spores flanked by small rods forming a crest on each side of the spore.

The pore is either imperceptible, as in the majority of **Melampsoraceae**, or quite evident in the thick or brown-stained wall; on the thin-walled or colorless urediospores the pore may be revealed only after special treatment. It can best be seen in the germinating spore, but here the air bubbles inside the spore often interfere. In most cases it is sufficient to boil the spores in dilute lactic acid, and subsequently to stain their colorless wall lightly with soluble blue dissolved in lactic acid. Klebahn recommends for this staining a rather concentrated solution of chloral hydrate with the addition of iodine; from my experience this method gives excellent results, homogenizing the spore contents. The pores become more conspicuous if only a drop of fluid is placed on the slide, so that the coverslip is pressed down on the preparation by the capillary force. P. Dietel achieved the same effect by pressing down the preparation with a needle. In all these cases the pore appeared as a disk or, if at the margin of the spore (in the optical section of the spore wall), as a bright stripe. The number of pores is rather constant in each species and therefore a specific characteristic; it ranges from one to ten. When they are few in number the majority are found in almost the same plane: in the middle of the spore, i.e., equatorially, and in the upper third of the spore — supraequatorially; less often in the lower third of the spore — subequatorially; rarely, at the very base of the urediospore.

In several species, particularly of **Puccinia** parasitizing **Compositae**, the spore wall swells near the pore, forming a lenticular or even hemispherical colorless papilla.

45 The urediospore contents are frequently colored a reddish-orange tint, but there are also colorless contents, mainly in species in which the aeciospores are also colorless.

In some rusts two kinds of urediospores are produced. The difference is most pronounced in certain species of **Uredinopsis**; in these, thin-walled urediospores with a slender beak and two rows of rod-shaped warts develop in the beginning of the summer, whereas at the end of the summer ellipsoid urediospores appear, their entire surface verrucose. More often the difference between urediospores consists less in their shape than in the thickness of the spore wall, its sculpture and number of pores. Occasionally, the thick-walled spores remain attached to the pedicel and resemble teliospores. If the difference between the thin-walled and the thick-walled spores is marked the latter are known as amphispores (Carleton, 1901). Arthur designated them with the numeral II.* Amphispores are apparently instrumental in preserving the fungus during the winter; they germinate after a period of rest. The vegetative hyphae arising from the urediospores infiltrate in the plant through the stomata.

In the development of rust fungi the urediospores function as primary propagators since they can again produce uredia. Therefore, some species can develop without any other stages. In these conditions hibernation proceeds through uredic pores; in the majority of cases the urediospores cannot germinate after hibernation, but then, the uredial primordia preserved on the leaves overwintering under the snow (on winter crops for example) continue their development with the onset of the warm weather.

Urediospores are formed in uredia. In most genera the latter are naked, surrounded only at the periphery by the torn epidermis. In many rust species the uredia are surrounded by paraphyses, filaments expanding at the apex into clavoid, globoid, or ellipsoid caps. Ellipsoid paraphyses are most characteristic of **Melampsora**. Occasionally, the paraphyses are joined to each other at the basis as in **Ochropsora**, **Leucotelium**, and **Aplospora**. In the latter genus the free apices of the paraphyses flex inward and, slanting over the urediospores, form a sort of peridium. **Pucciniastreae** and the genus **Cronartium** have true hemispherical peridia, of small cells, more or less radially elongated at the base, growing at the apex isodiametric and small; at the very tip the peridia have a small aperture; usually surrounded by cells with thicker walls and smooth or echinulate walls; in the genus **Melampsoridium** the cells taper to sharp points. In some **Melampsoraceae**, as for example in **Hyalopsora** and **Melampsora**, the uredium has in the beginning of its development a rudimentary peridium which disappears at maturation.

TELIOSPORES of rust fungi are extremely varied, providing characteristics significant for species differentiation. In **Melampsoraceae** the teliospores are devoid of pedicels, lying directly on the vegetative filaments of the mycelium, whereas in **Pucciniaceae** teliospores are usually borne on distinct pedicels. Of the genera found in the USSR only the teliospores of **Ochropsora** are nonpedicellate, but then, these "teliospores" are in essence basidia (see below). In the genus **Aplospora** and at least in part of the genus **Cerotelium** the teliospores are also nonpedicellate. These genera are closely related to **Ochropsora**, but their teliospores germinate with the formation of typical external 4-celled basidia. According to Arthur and other authors who adopt the formal point of view, these genera belong

to Melampsoraceae; but the aecial structure indicates their kinship with Pucciniaceae. In Pucciniastreae (Figure 4, a—d) of the family Melampsoraceae the unicellular teliospores divide longitudinally into two,
46 four, or more cells; they are either subepidermal or intraepidermal. In the genus Cronartium (Figure 4, g) unicellular teliospores are fused into a column emerging above the surface. In the genus Chrysomyxa (Figure 4, f) unicellular teliospores rise in vertical chains, together forming waxy red sori. In Melampsora (Figure 4, h) the unicellular teliospores unite, forming small subepidermal or subcuticular crusts. In the genus Coleosporium (Figure 4, e) teliospores are waxy, their cells cylindrical, usually thickened at the apex; before germination each spore divides transversally into four cells, each of which gives rise to a single basidiospore. In this way the "teliospores" of Coleosporium are virtually basidia. In the genus Phakopsora the dark-stained teliospores form chains which remain covered by the epidermis. The other genera of Melampsoraceae are not found in the USSR and will not be dealt with.

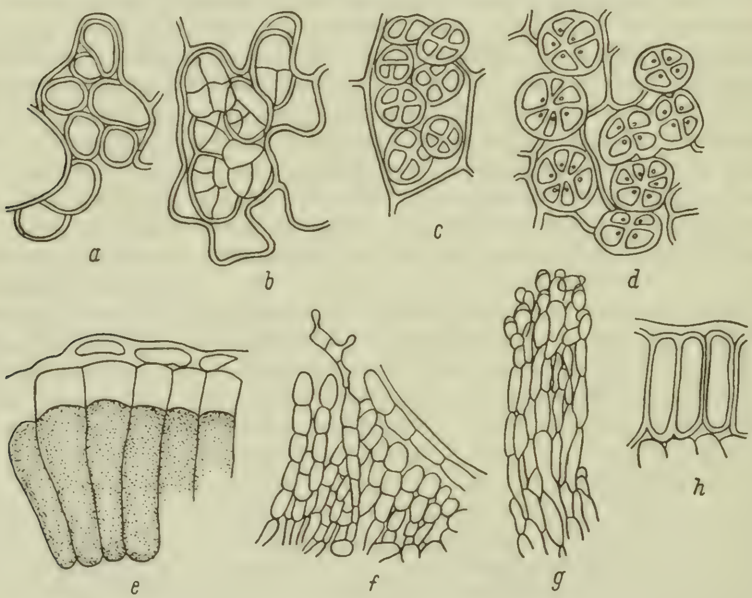


FIGURE 4. Teliospores of genera of the family Melampsoraceae:

a — Melampsorella; b — Hyalopsora; c — Uredinopsis; d — Thekopsora; e — Coleosporium; f — Chrysomyxa; g — Cronartium; h — Melampsora. (After Arthur, 1929.)

In the family Pucciniaceae the number of genera and their diversity is even greater. Until relatively recently genera have been differentiated by the number of cells forming complex teliospores. Unicellular teliospores have been referred to the genus Uromyces: 2-celled — to Puccinia; triquetrous, 3-celled teliospores — to the genus Triphragmium; teliospores of three or more cells stacked one upon another — to Phragmidium; teliospores gathered in caps on pedicels, either simple or composed of several filaments — to the genus Ravenelia.

47 Now, when new, less conspicuous features in the structure of the teliospore are taken into account in the determination of genera, in conjunction with differences between other spore stages the number of genera has considerably increased, and the number of cells in the spore has lost some of its former significance, so that 3-celled species of **Puccinia** (for example, **P. elymi**), 4-celled species of **Triphragmium** (**T. anomalum**), and 2-celled species of **Phragmidium** (**P. kamtschatkae**) are now well known. At the same time it is quite clear that the genera **Uromyces** and **Puccinia** should be united in one genus because the number of genera fully identical in all features, even in the selection of hosts, is continuously rising; moreover, they are differentiated only by the number of cells in the teliospores, from which it may be concluded that individual species in a genus are more closely related to species of the other genus than to other species of the same genus.

In many species of **Puccinia** unicellular teliospores are encountered in varying numbers among the normal bicellular teliospores. These are known as mesospores. In **Puccinia porri**, **P. anomala**, and **P. sanchi** telia consist almost entirely of mesospores.

In many rusts the teliospores require a rest period before they are able to germinate. Development of this ability is determined by the winter cold and by repeated alternate wetting and drying. In other rust fungi the teliospores have acquired the ability of germinating soon after their development (**Lepto**-forms). Among these, autoecious species reproducing in the main only by teliospores (**Micro-Uredinales**), and developing on leaves which do not overwinter produce several generations in the course of the summer, for example, **P. arenariae**. Only **Lepto**-species producing teliospores on evergreen leaves give rise in summer to a single generation, as for example, **Puccinia buxi** and **Chrysomyxa abietis**; these overwinter by the mycelium in the evergreen leaves of **Buxus** or **Picea**. Some spurge rusts also produce only one generation; their teliospores germinate immediately upon maturation, but develop on a diffuse mycelium. In these species the mycelium apparently infiltrates, as in all species with diffuse mycelia, the wintering buds of the host plant.

Dioecious **Lepto**-species develop teliospores either in the spring, giving rise to aecia in summer (species of **Gymnosporangium** and **Chrysomyxa**[1]), or at the end of summer, developing aecia in the fall (**Puccinia dispersa**), whereupon the fungus succeeds in infecting with aeciospores the live overwintering leaves (in the given case of winter rye).[2] In species of **Cronartium** teliospores develop in the second half of summer and germinate into basidiospores which infect the pines; their mycelium developing in the bark produces aecia, usually within several years. A similar development takes place in species of **Coleosporium**;

[1] The majority of species of **Milesia** produce teliospores in spring and aecia in summer, on fir trees; the same pattern of development is encountered in **Melampsorella symphyti**. On fir trees infected with **Melampsorella cerastii** thickenings appear in May on the twigs in which the mycelium is perennial, giving rise in the subsequent years to shoots with aecia on their leaves. Infection of fir leaves with **Hyalopsora aspidiotus** occurs in spring, but spermagonia appear on the leaves after a year, and aecia develop only one year later, in the third year after infection.

[2] Reference is here made to the success of **P. poarum** in completing within a year two (or more ?) developmental cycles on coltsfoot (**Tussilago farfara**) and on meadow grasses.

the basidiospores from the germinating teliospores infect pine leaves, on which aecia are produced in the following spring. In all these fungi, in addition to those producing either several generations per year, or
48 one (as in Gymnosporangium, Coleosporium, Cronartium, Milesia, Hyalopsora, Melampsorella), or two (as in Chrysomyxa), the hosts are represented by evergreen plants, while in Micro-Uredinales with one generation of teliospores the mycelium overwinters in the evergreen leaves or overwintering buds.

In some rusts two different generations of teliospores develop. Most remarkable from this aspect are species of the genus Pucciniostele. Their cycle of development is as follows. At the beginning of summer caeomoid aecia are produced with distinct aeciospores; in midsummer teliospores begin to appear in the same chains, whereby each aeciospore corresponds to two rows of cells which remain joined in columns. When the mycelium develops from the aeciospores at the end of the summer, secondary waxy telia arise from the unicellular rows; in fall, the rows separate from each other and break up into irregular fragments. Some species of Puccinia also produce two kinds of teliospores. In the early summer smooth, thin-walled, pale teliospores develop on sturdy pedicels, germinating as soon as mature, whereas in midsummer telia begin to appear with teliospores on deciduous pedicels, with thicker and dark-colored walls, apparently germinating after a rest period. These biform teliospores are produced by Puccinia polemonii, P. albulensis, P. chrysosplenii, and P. veronicarum. The pulverulent spores of P. albulensis and P. chrysosplenii are not altogether smooth; in the first the wall is finely punctate, in the second, faintly striated longitudinally.

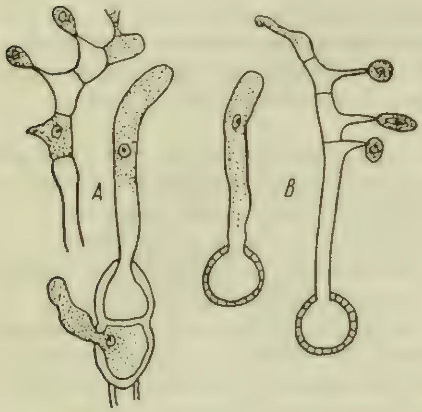


FIGURE 5. Puccinia polemonii:

A — Puccinia malvacearum; B — Endophyllum sempervivi. (After Arthur, 1929.)

BASIDIA represent the main determinative state of rust fungi in the system of stages. In the vast majority of rusts basidia develop from germinating teliospores (Figure 5). Each cell of the teliospore gives rise to one basidium; with its development arise hyphae known as promycelia, the nuclei of which divide meiotically mostly into four, rarely into two nuclei; the septa arising between them and between the lower nucleus and the anucleate pedicel give rise to 4-celled or 2-celled basidia. Each basidial cell gives off near the upper end a lateral, short branchlet — the sterigma; the nucleus passes into the tip of the sterigma which constricts under the basidiospore. In some genera basidia develop inside the teliospores. In the tropical genus Chrysopsora each of the two thin-walled cells of the teliospore, borne by a pedicel and resembling teliospores of Puccinia, divides into four cells, each of which gives rise to sterigmata projecting through the walls of the teliospore cells. In

genera **Coleosporium** and **Ochropsora** the teliospore is cylindrical, initially unicellular, nonpedicellate, subsequently dividing into four cells
49 and transforming into a basidium; in these genera the teliospores are devoid of pedicels, and may rightly be considered basidia, with the inference that these genera have no teliospores. In some cases basidia do not give rise to sterigmata but split into four cells; this is a teratological phenomenon.

The shape of basidiospores is characteristic of individual rust genera. In the majority of **Melampsoraceae** (with the exception of **Coleosporium**) and also in genera of the subfamily **Phragmidieae** the basidiospores are perfectly globoid; in many **Pucciniaceae** they are ellipsoid, extruded on one side into a papilla by which they are borne upon the sterigma; this side is straight while the opposite side is convex, so that the sides of the basidiospore are unequal, almost reniform. The basidiospores are forcibly discharged from the sterigmata. They are very delicate and tend to perish when dried, although observations in nature indicate that basidiospores of species of **Gymnosporangium** and **Chrysomyxa** may be carried over great distances. The shoots emerging from basidiospores usually pierce the walls of the host's epidermis.

Having become acquainted with the external morphology of rust fungi we shall now turn to the internal morphology — CYTOLOGY.

Like all higher fungi rust fungi have two phases or generations — h a p l o i d (sexual generation, gametophyte) and d i p l o i d (asexual generation, sporophyte). The haploid phase consists of uninucleate cells, and the diploid of binucleate cells; only at the end of the diploid phase the two nuclei in the cell unite, whereupon a reduction division takes place with the formation of four haploid nuclei.

The haploid phase begins with the basidiospores containing one nucleus. The mycelium produced by the germinating basidiospore consists of uninucleate cells. On the uninucleate mycelium develop spermagonia (if they are part of the developmental cycle of the species) and the primordia of the first spore stage. In many (all ?) species, two of the four basidiospores on the basidium are of one mating type (+), and two of the opposite mating type (-), while the mycelium obtained from the basidiospores is of dual mating type and designated heterothallic. In rusts heterothallism was discovered in 1927 by Craigie. In species comprising an aecial stage heterothallism is manifest when upon infection with one basidiospore spermagonia are formed on the mycelium and aecial primordia are laid; their further development inhibits initiation of an asexual union. This explains also the sexual nature of spermatia in the spermagonia. If spermatia are transferred from one spot of the spermagonium onto another spot (of the opposite mating type) development of aecia will soon produce aeciospores. The spermatia fuse with the periphyses of the spermagonium or with the specific mycelial branchlets which enter the stomata. The mechanism by which the haploid mycelium is converted into a diploid one is not yet accurately known. According to Allen, in **Melampsora lini** spermatia germinate into a mycelium whose cells copulate at the base (bottom) of the aecia with the cells of the mycelium initially developed by the spermagonium. In this case the fusing cells adjoin only with their upper parts where their walls dissolve, and thus produce a binucleate cell.

Before Craigie discovered (1904) the sexual function of spermatia, only the last part of the sexual act was known, i. e., confluence in pairs of the basal cells of aecial primordia. The more recent observations recorded by Allen in **Melampsora lini** united these two phases of the sexual process, hitherto considered strictly disparate. Craigie's discovery of
50 the sexual function of spermatia enables hybridization of specialized forms or biological races of rust species, whereby the hybrids acquire new properties in comparison with those of the initial form. In some cases the diploid phase apparently proceeds by anastomosis of the mycelia of different mating types, along their whole length, not only of the basal cells of the aecia. The binucleate basal cells formed produce basipetally the spore mother-cells from which larger cells later separate upward — the aeciospores, and narrower cells downward — the intercalary cells. The first separated upper cells fuse (in true aecia) into a roof of the peridium, whereas the marginal basal cells, surrounding the young aecia, form the aecial peridium, while the middle cells form the aeciospores. The peridial cells usually remain closely joined, whereas the aeciospores become free after disintegration of the intercalary cells, and are ejected from the erumpent aecia. Upon division of the diploid cells the daughter-cell nuclei are a product of both nuclei of the mother-cell, so that throughout the diploid phase each cell is derived from both nuclei of the fused primordial cell.

In rust species devoid of aecia the diploid phase is apparently acquired by anastomosis of the mycelium formed either at the base of uredia (in **Brachy-Uredinales**), or of the telia (in **Micro-Uredinales**). Thus the diploid phase always originates from the haploid mycelium arising from basidiospores of different mating types, irrespective of the spore type developing on this first diploid mycelium in connection with the life cycle of the species. It is therefore erroneous to state that aecia develop on a haploid mycelium; it should be stated that aecia (or primary uredia, or primary telia) represent the first form of sporophore on a diploid mycelium, since aecia develop only later, with the appearance of the binucleate mycelium.

In **Brachy-Uredinales** the first form of sporophore is represented by the primary uredium. The urediospores evolved will already be binucleate, since this is one of the above-mentioned means of developing a binucleate mycelium. In **Eu-Uredinales** the diploid mycelium arising from aeciospores initiates the uredia. In rusts with beaded urediospores (**Coleosporium, Chrysomyxa**) the development follows the pattern of aeciospores with the formation of intercalary cells. In rust fungi in which urediospores are produced singly, the basal cells evolving in young uredia abstrict the cell (urediospore mother-cell) which later divides into the upper cell — the urediospore, and the lower cell — the pedicel. Under the pedicellate urediospore formed in this way the basal cell gives rise to a lateral growth which is later also transformed into a pedicellate urediospore. Hence, one basal cell may give rise to several urediospores, leading to the formation of clusters, not of chains as in aecia or uredia of **Chrysomyxa** and **Coleosporium**. Each urediospore has two nuclei.

The development of teliospores is extremely varied according to their diversity in the rust species, for here it is impossible to decide on the process, especially since it cannot be traced in all genera. In the genera **Puccinia** and **Uromyces** the teliospores develop in the same way as their urediospores; in **Puccinia** the mother-cell divides transversally into

51 two cells. In **Phragmidieae** the teliospores do not develop acropetally as in **Puccinia** but basipetally, i.e., first the upper cells develop into teliospores and only later and gradually all the lower-lying cells. In this connection it is interesting to compare the development of 3-celled teliospores of **Triphragmiopsis** and **Nyssopsora** (**Puccinieae**) with those of **Triphragmium** (**Phragmidieae**). The mature teliospores so closely resemble one another that at first glance the species connected with them would be referred to a single genus, **Triphragmium**; the teliospores consist of two upper cells in a row, with the third cell underneath them. In **Triphragmiopsis** and **Nyssopsora** the teliospore mother-cell is first divided by a horizontal septum into two cells and afterward the upper cell thus formed is also divided by a vertical septum. In **Triphragmium** the upper cell separates first; the lower cell then expands displacing the upper cell laterally, and is divided by a septum perpendicular to the first septum and diagonal in relation to the axis, and, finally, under the two adjoining upper cells a transverse septum separates the third basal cell from the pedicel.

Each cell of the teliospore contains two nuclei which fuse very soon. However, in **Uromyces ficariae** and **U. rumicis** the nuclei do not fuse even in mature spores. The fused nucleus (containing 2 x chromosomes) grows and divides by reduction division into four nuclei with 1 x chromosome each. In the basidia the four nuclei separate from each other by septa with the formation of a 4-celled basidium; later, each cell gives rise to a protuberance into which the respective nucleus migrates, the outgrowth finally transforming into a basidiospore borne upon a short or elongate thin sterigma.

From the brief review of the behavior of nuclei in the developmental cycle of rusts it is evident that the sexual process is as prolonged as in higher fungi; it begins with the fusion of cells (plasmogamia), while the fusion of nuclei (caryogamia) takes place only at the end of the developmental cycle, after which the haploid phase sets in again very soon.

CLASSIFICATION AND NOMENCLATURE

The classification of rust fungi has long been based only upon the characteristics of teliospores. Dietel's system (1897a, p. 35) was entirely artificial. Rust fungi were divided by Dietel into 4 families: **Endophyllaceae** (3 genera), **Schizosporaceae** (2 genera), **Melampsoraceae** (14 genera), and **Pucciniaceae** (12 genera). In the volume published in 1900 (201. Lief., p. 547) Dietel introduced a new system, dividing the rusts into 4 families: **Melampsoraceae** (4 genera), **Coleosporiaceae** (5 genera), **Cronartiaceae** (15 genera), and **Pucciniaceae** (14 genera). This system proved to be as unnatural as the first.

A significant step forward was made with the publication of the system advanced by Arthur (1906, p. 331), in which besides the characteristics of teliospores the author takes into account the valuable specific structure of the spermagonia. Arthur presents 75 genera, of which 11, being scarcely known, could not be included in the system. The great number of genera is explained by the fact that, when separating the genera, the author took into

account the number of stages in the life cycles. The latter circumstance in conjunction with Arthur's strict adherence to the priority of names, which involved the use of generic designations different from those currently applied, led to the rejection of the proposed system in its entirety, with both its valuable and its superfluous innovations. Arthur divided the rust
52 fungi into the following families and subfamilies, and the latter into tribes: family **Coleosporiaceae** with the subfamilies **Coleosporiatae, Ochropsoratae,** and **Chrysopsoratae** (with 2 tribes); family **Uredinaceae** (=**Melampsoraceae**) with the subfamilies **Pucciniastratae** (with 2 tribes), **Chrysomyxatae, Uredinatae,** and **Cronortiatae**; family **Aecidiaceae** (= **Gymnosporangiaceae**) with subfamilies **Raveneliatae** (with 3 tribes), **Uropyxidaxae, Phragmidiatae** (with 2 tribes), **Aecidiatae,** and **Dicaeomatae** (= **Puccinieae**) (with 2 tribes). The subfamilies and tribes comprise closely related genera, except for the family **Coleosporiaceae** where subfamilies are included according to the purely artificial feature of basidia formation inside the teliospore wall.

In 1922 — 1925, Dietel published in the "Annales Mycologici" (XX — XXIV) a series of studies in which certain genera and their relationships are thoroughly analyzed, while great emphasis is placed on the host — parasite relationship. These studies constituted the preliminary work to a new treatment of rust fungi published in a subsequent work, "Die Natürlichen Pflanzenfamilien." In the six volumes of this work, printed in 1928. Dietel presents a new classification, in the main similar to the system proposed by Arthur; according to the state of knowledge of rust fungi, it may be considered closer to the natural classification, although upon thorough examination of the life cycles, especially of non-European genera, it seems that certain groups should, probably, be divided. We present on p. 60 an extract from Dietel's classification dealing with the genera of rust fungi presumably and actually found in the USSR.

Apart from morphological characteristics the species of parasitic fungi and of rusts in particular are determined by their behavior toward the host plants. Up to a certain point this may be compared with the criteria of geographical distribution in the systematics of higher plants. The behavior toward the host plant can be experimentally tested.

It follows from the aforestated that parasitic fungi comprise biological and morphological species.

Rust fungi can develop, as a rule, on a limited number of host plants, whereby an increasingly narrower specialization, or adaptation of the rusts to the host may be recorded. Apparently representatives of very few fungal species are able to develop on representatives of different plant families. To these belong, in the USSR, **Cronartium flaccidum,** which forms uredia and telia in representatives of numerous families, and **Puccinia isiacae** and **P. cynodontis,** which are plurivorous in the aecial stage. However, these species developing in plants of different families behave differently toward the species of a single genus. For example, **Puccinia isiacae** develops aecia in **Galeopsis tetrahit** and **Veronica arvensis,** but fails to infect **G. speciosa** and **V. serpyllifolia.** As a rule, no kinship is found in heteroecious species between the hosts of the uredio- and telio-stages and those of the aecial stage. Among the autoecious species some, as for example, **Puccinia malvacearum,** may develop also in hosts of different genera of the same family. The majority of these species infect only plants of a single genus,

or even of a single species. Some rusts specialize even more narrowly, evolving races adapted to definite races (varieties) of the host. Usually, specialization does not involve morphological differentiation of the fungi. There are no morphological differences between biological species, or, if there are, we have failed to detect them; the species are differentiated only in relation to the hosts. Closely related biological species are designated also as "sister-species" (species sorores), or, if it be assumed
53 that such species have evolved through adaptation to a certain host, "habit races" (Gewohnheitsrassen). Sometimes, since fungi referred to a single species are distinguished by the hosts selected they are designated by the names of the forms of specialization, as for example, **Puccinia graminis** forma specialis **tritici** parasitizes wheat, f. sp. **avenae**, oats, etc. When a still narrower specialization of both fungal species and specialized form is detected in the behavior of the grain rusts toward the host variety, for example wheat, then physiological races are involved, or biotypes, and are designated by serial ciphers. Specialization is sometimes less strict and reflected only by the intensity of infection of the host, whereby one plant is severely infected and another slightly attacked. Often infection sets in, patches appear and even rudiments of sporophores; then development ceases.

In the systematics of rust fungi, forms morphologically indistinguishable were united at first in one species, for only their similarity was taken into account. The crisis arose when the number and location of the pore in urediospores was adopted as a criterion for the differentiation of species. At almost the same time biological specialization was introduced as a means of species determination with the aid of experimental infections of different hosts with the same fungus. Since in this case it appeared that in most instances species of different, though closely related genera were not infected by the same fungus which evolves "biological species" in closely related genera, it remained to describe the fungi encountered in individual genera as separate species, although morphologically indistinguishable, following failure to prove experimentally the independence of the species. But more recently the trend toward a return to morphological species has been felt, especially in North America (Arthur and his school) and in Norway (Jørstad); however, it is going a little too far when morphologically distinct fungi are not considered independent species, as in Arthur's "Manual," where he unites in one species **Uromyces trifolii** (as a sub-species ?), **U. trifolii trifolii - repentis**, and **U. trifolii fallens**, although the latter is readily distinguished by the number of germ pores in urediospores.

The gradual transition from morphological species through biological species and specialized forms to physiological races makes difficult a clear-cut definition of species in rust fungi; in each particular case the mycologists find a different solution to this problem. We may say that any definition of species strictly adhering either to morphological or to biological criteria leads to absurdity. More than in any other plant group, a species of parasitic fungi, and first and foremost of the extensively studied rust fungi, should rightly be considered a system in itself, or even a continuing process.

It is now taken for granted that rust fungi have evolved (and, apparently, continue to evolve) concomitantly with the evolution of their hosts;

changes proceed very slowly and gradually, and it is probably not by mere chance that the majority of biological species are found among the parasites of **Compositae**. We suggest recognition of the biological species or their integration as subspecies in order to avoid a return to the mixture of forms requiring for their differentiation experimental infections with all the difficulties involved.

A few words should be said about the principles of nomenclature. Until 1905, apparently following an unwritten law, the names of all fungal stages had the right to priority in the autoecious rust fungi, whereas for hetero-
54 ecious species priority of the name of the aecial stage was not accepted; however, some authors (Wettstein, Lagerheim, Arthur until 1934) acknowledged the priority of the names of aecial stages. According to the international rules of nomenclature published in 1912, and ratified at the Congresses of 1905 and 1910, paragraph 49-bis, the right to priority belongs only to names of perfect forms, while "the perfect state is that which in rust fungi will end in teliospores or their equivalents." If this rule is understood as conferring the right of priority only on names given for the teliospore stage, then, firstly, it would lead to changes of many accepted names and, secondly, it would often make it difficult to determine whether an author (referring to authors of the mid-19th century) described under the generic name **Uredo** the uredial stage or the telial stage, for example, species currently referred to genus **Uromyces**. To acknowledge priority of the aecial stage is inconvenient because, in some instances, the description of this stage fails to indicate whether it refers to an autoecious or heteroecious species. The aecia of **Puccinia vagans** (**P. epilobii tetpagoni**) and **P. veratri** on **Epilobium**, **P. albescens** and **P. argentata** on **Adoxa**, **P. bupleuri** and **P. behenis** on **Bupleurum** are indistinguishable; aecia of **P. variabilis** and **P. silvatica** on **Taraxacum** are hard to differentiate, etc. Hence, we must interpret the paragraph 49-bis as Arthur did (1934a, pp. 471—476), i.e., to the effect that the "perfect state" is a stage of the sporophyte including the uredial and telial stages; the designation aecial stage, developing on gametophytic mycelia, does not give the right to priority. We also agree with Arthur's proposal to consider the rules of nomenclature valid for rust fungi from the year decided on by the Congress for Seed Plants, viz., 1753, the year in which "Species Plantarum" by Linnaeus appeared, and not the year Persoon published the "Synopsis methodica fungorum" (Persoon, 1801).

OUTLINE OF FAMILIES, TRIBES, AND GENERA

(After Dietel, in "Die Natürlichen Pflanzenfamilien...," 2nd Edition, Vol. 6, 1928)[1]

I. Teliospores nonpedicellate, for the most part enclosed in pustules or columns, occasionally developing intraepidermally, or loosely dispersed subepidermally. Species mainly autoecious, aecia enclosed by peridia in conifers, or aecia without peridia — caeomoid — in angiosperms and in

[1] Only genera known from the USSR — or that might be found in the USSR — are taken into account.

conifers; in angiosperms only in genus **Melampsora**, species of which are also autoecious. Microspecies are also known (only with teliospores) in conifers, rarely in angiosperms . . . . Family **Melampsoraceae**.

II. Teliospores mostly pedicellate; if pedicel absent aecia with peridium; or teliospores in chains, or capitate, very diverse in shape, with one or more cells. Aecia with peridia, occasionally rudimentary, or without peridia but paraphysate, seldom without peridia and paraphyses. Aecia on conifers unknown . . . . Family **Pucciniaceae**.

55 Family MELAMPSORACEAE

I. Heteroecious species, aecia with peridia on conifers, or microspecies on conifers.
  - A. Urediospores do not develop in chains, uredium covered by hemispherical peridium, occasionally replaced by a crown of paraphyses.
    - 1. Teliospores longitudinally septate or 1-celled, contained in a one-layered crust, subepidermal or intraepidermal, rarely scattered under the epidermis . . . . **Pucciniastreae**.
      - a. Uredio- and teliospores on ferns, aecia on conifers.
        - + Aecio-, uredio-, and teliospores colorless.
          - * Teliospores intraepidermal . . . . **Milesia** White (**Milesina** Magn.).
          - ** Teliospores subepidermal. . . . . **Uredinopsis** Magn.
        - ++ Aecio-, uredio-, and teliospores with yellow contents. Teliospores in the spring intraepidermal . . . . **Hyalopsora** Magn.
      - b. Uredio- and teliospores on angiosperms.
        - + Teliospores intraepidermal.
          - * Teliospores longitudinally septate.
            - o No urediospores. Teliospores on greatly elongated stems . . . . **Calyptospora** Kühn.
            - oo Urediospores present, teliospores crustose on leaves, more or less pronounced. . . . . **Thekopsora** Magn.
          - ** Teliospores 1-celled, developing in spring. . . . . **Melampsorella** Schroet.
        - ++ Teliospores subepidermal.
          - * Teliospores longitudinally septate. Cells surrounding the peridial opening of uredia not extruded into spines. . . . . **Pucciniastrum** Otth.
          - ** Teliospores 1-celled. Cells surrounding peridial opening of uredia extruded into spines. Aecia on larch needles . . . . **Melampsoridium** Kleb.
    - 2. Teliospores 1-celled joined in cylindrical columns, growing from their base . . . . **Cronartieae**. Aecia on pine trunks and branches . . . . **Cronartium** Fries.

B. Urediospores in chains, uredia without noticeable peridia.

1. Teliospores in rows occasionally ramified, enclosed in compact pulvinate clusters. Each teliospore produces typical basidia . . . . **Chrysomyxeae.**
Aecia on spruce needles, uredio- and teliospores on leaves of evergreen plants, or only teliospores (microspecies), on spruce needles . . . . **Chrysomyxa** Ung.
2. Teliospores solitary, contained in waxy, compact, pulvinate clusters, at first 1-celled, later transversally dividing into 4 cells, transforming into basidia: each cell of the teliospore (basidium) produces one basidiospore . . . **Coleosporieae.**
56 Aecia on pine needles, uredio- and teliospores on different plants, or only teliospores (in microspecies separated in genus **Gallowaya** Arth.) . . . . **Coleosporium** Lév.

II. Aecia, caeomoid, or with rudimentary peridia.

A. Teliospores 1-celled, rarely 2-celled, contained in single-layered crusts . . . . **Melampsoreae.**
1. Teliospores with brown wall. Uredia with capitate paraphyses . . . . **Melampsora** Cast.
2. Teliospores with pale wall. Uredia unknown. In the USSR species with aecia unknown . . . . **Chnoopsora** Diet.

B. Teliospores 1-celled, contained in many-layered lenticular telia. Uredia with hemispherical peridia, or, frequently, with a crown of clavate paraphyses. . . . . **Phakopsora** Diet.[1]
See also among Pucciniaceae: **Ochropsora**, **Aplospora**, **Baeodromus**, **Pucciniostele**.

Family PUCCINIACEAE

I. Teliospores 1-celled pedicellate, germinating soon after maturation at the base of the spore, into basidia not completely emerging from the spore wall. Spermagonia and aecia immersed; the latter caeomoid. Urediospores single, pedicellate, with pores. Aecio-, uredio-, and teliospores with orange-colored contents and colorless wall. Only on representatives of family **Oleaceae** . . . . **Zaghouanieae.**
(In the USSR only **Zaghouania** Patouillard might be encountered (?))

II. Teliospores 1-celled nonpedicellate, with colorless wall, germinating immediately upon maturation. Spermagonia subcuticular, adjoining epidermal cells, conical. Aecia with peridium. Uredia paraphysate. . . . . **Ochropsoreae.**

A. Teliospores convert into basidia by tranverse septa. Aecia on **Ranunculaceae** (**Anemone**), uredia and telia on **Rosaceae**. . . . . **Ochropsora** Diet.

B. Teliospores germinate giving rise from the apical spore to 4-celled basidium.

[1] The position in the system of this genus, characteristic of areas with warm climates, is uncertain, since in no species is the complete cycle of development known. Dietel refers it to the tribe **Cronartieae.**

1. Teliospores 1-celled, not in chains. . . . Aplospora Mains.
2. Teliospores 1-celled, in chains. . . . . . Cerotelium Arth.[1]

III. Teliospores 2-celled, pedicellate. Spermagonia subcuticular, adjoining the epidermis, conical. Aecia with peridium, opening in a few lobes; aeciospores with colorless contents. Aecia on **Ranunculaceae** uredio- and teliospores on **Rosaceae** (**Prunoideae**), or only teliospores on **Ranunculaceae**. . . . . Tranzschelieae.

57 A. Teliospores with brown wall, strongly compressed at the septa . . . . Tranzschelia Arth.

B. Teliospores with colorless wall and colorless contents, germinating soon after formation. . . . . Leucotelium Tranz.

IV. Teliospores 1- and 2-celled, pedicellate. Spermagonia subcuticular. Aecia caeomoid (without paraphyses). Aeciospores and urediospores with orange-colored contents. Aecia or, if absent, primary uredia on diffuse mycelium. Basidiospores elongate. On **Rosaceae**. . . . . Gymnoconieae.

A. Teliospores 1-celled . . . . Trachyspora Fuck.

B. Teliospores 2-celled. . . . . Gymnoconia Lagerh.

V. Teliospores with one or more cells, pedicellate, seldom in chains, pedicels inconspicuous. Spermagonia subcuticular. Aecia caeomoid, with or without paraphyses. Aeciospores and urediospores with orange-colored contents. Basidiospores globoid. . Phragmidieae.

A. Teliospores developing in chains, resembling a pluricellular spore, with colorless wall and colorless contents. No aecia. . . . . Kuehneola Magn.

B. Teliospores with 2 or more cells, disposed in one row, with brown walls.

1. First stage in the form of primary uredia.

a. Teliospore with one pore per cell. On **Rosaceae** (**Potentilleae**) . . . . Frommea Arth.

b. Teliospore with more pores per cell. On **Rubus**. . . . . .Phragmotelium Syd.

2. First stage in the form of caeomoid aecia, or having only teliospores; with 2 or more pores, seldom one.

a. Teliospores pedicellate. . . . . . Phragmidium Link.

b. Teliospores with inconspicuous pedicels, resembling beads. Xenodochus Schl.

C. Teliospores 3- or 4-celled, triquetrous or tetrahedral, with one pore per cell. No aecia. On **Filipendula**. . . . . Triphragmium Link.

VI. Teliospores pedicellate, with relatively distinct three-layered walls, 1- to 3-celled, in the majority of genera with two or more pores per cell. Spermagonia subcuticular. Tropical or subtropical genera, almost exclusively in America. . . . . Uropyxideae. Teliospores 2-celled, with 2 pores per cell. In the USSR one species, only with teliospores, on **Fraxinus**; one species with aecia, uredio- and teliospores (genus **Cumminsiella** Arth., 1933) on **Berberis** (**Mahonia**), recently introduced in western Europe from North America. . . . . Uropyxis Schroet.

[1] The genus apparently comprises heterogeneous species of which **Cerotelium fici** (Cast.) Arth. (= **Physopella fici** Arth.) is encountered in the USSR, scarcely related to Ochropsoreae.

VII. Teliospores with one or more cells, the former frequently 2 — 3 on a common pedicel; the pluricellular mostly with longitudinal septa forming either globoid or flat caps. Spermagonia, where known, subcuticular. Mainly in the tropics and subtropics. The genera distributed in the USSR scarcely characteristic of the tribe. . . . . **Ravenelieae.**

58 A. Teliospores 1-celled; in typical species width exceeds length, pedicellate, pedicels shed together with the spores. Spermagonia subcuticular. Aecia absent. . . . . **Pileolaria** Cast.

B. Teliospores 3-celled, triquetrous.

1. Teliospores chestnut-brown, verrucose. with 2 pores per cell. Spermagonia unknown. Aecia, if present, with peridium. On **Ranales** (**Berberidaceae, Ranunculaceae**) . . . . **Triphragmiopsis** Naumov.
2. Teliospores with grayish-black opaque walls, echinulate, pointed or anchor-shaped, with several pores per cell. Spermagonia and aecia unknown. On **Umbelliflorae** (**Umbelliferae, Araliaceae**) only teliospores; on **Meliaceae** and **Sapindaceae** with uredio- and teliospores apparently heteroecious. . . . . **Nyssopsora** Arth.[1]

C. Teliospores in hemispherical heads formed by 2 — 3 rows of spore cells under which is found a cell-cyst. No pedicels. The head drops following disintegration of the cell-row under the cyst; under the firest head a second may develop (Figure 6). Spermagonia subcuticular. Aecia without peridia. Urediospores single, pedicellate. . . . . **Nothoravenelia** Diet.[2]

VIII. Spermagonia immersed. Aecia with peridia. Teliospores mainly 2-celled. Urediospores known only in one (American) species. Characteristic: formation of gelatinous telia following gelatinization of outer wall of teliospores and of the long pedicel. Teliospores on **Cupressaceae**, aecia mostly on **Rosaceae — Pomoideae**. . . . . **Gymnosporangieae.**
In the USSR one genus . . . . **Gymnosporangium** Hedw. f.

FIGURE 6. Nothoravenelia japonica Diet. Section through a telium.

A — 1 or 2 spore layers, a cyst layer, a layer of separating cells; the cells can produce new spore-heads at their base; paraphyses seen at the sides; B — the layer of separating cells dissolved. (After L. I. Kursanov, N. I. Tseshinskaya, E. S. Klyushnikova, 1936.)

[1] See L. I. Kursanov, N. I. Tseshinskaya, E. S. Klyushnikova, 1936.
[2] The same.

IX. Spermagonia (where known) immersed. Aecia (where known) without peridia or with readily disintegrating peridia. Teliospores 1- or 2-celled, with colorless or pale walls. Disseminated mainly in the
59 Torrid Zone. In the USSR only one genus may be found. . . . . Eriosporangieae.

Spermagonia and aecia unknown. Urediospores single without perceptible pore. Teliospores 1-celled, with colorless wall, germinating soon, whereupon the wall of the apical spore gives rise to a 4-celled basidium separated from the empty spore by a septum. In Japan on species of **Smilax**. . . . . Blastospora Diet.

X. Spermagonia immersed. Aecia with peridium, at times rudimentary. Urediospores single, usually with evident pores. Teliospores 1- or 2-celled, in some species pluricellular, pedicellate, with one pore per cell. . . . . Puccinieae.

A. Teliospores 1-celled.

1. Teliospores single. . . . . Uromyces Link.
2. Teliospores produce compact lenticular sori covered by the epidermis. Teliospores remain joined for a long time. (According to later studies published by Mains (1934) the teliospores have short pedicels, which secede and disintegrate under the pressure of the newly emerging teliospores. Mains is right in finding insufficient justification for separating the genus from **Uromyces**). . . . . . Schroeteriaster Magn.

B. Teliospores 2-celled, occasionally with sori containing 1-, 2-, or 3-(4-)celled (**Rostrupia** Lagerh.) teliospores . . . . Puccinia Pers.[1]

C. Teliospores absent. Only aecia, the spores of which give rise to basidia. . . . . Endophyllum Lév.

XI. Teliospores develop in series, often more or less firmly joined at the
60 sides, 1- or 2-celled. Mostly tropical genera very diverse and scarcely known. Two genera found in the USSR (**Baeodromus** and **Pucciniostele**) are referred (the first by Arthur, the second by Kursanov) to **Melampsoraceae**. . . . . Pucciniosireae.

A. Teliospores small, surrounded by ruptured epidermis, in small groups; teliospores 1-celled, in short chains, brown or colorless. In America, from California to Guatemala 4 species on **Compositae**. A species from the Far East on **Urtica laetevirens** is referred to this genus with certain doubts. . . . . . Baeodromus Arth.

B. Spermagonia subcuticular. Aecia without peridium. No urediospores. Teliospores of two kinds: summer spores develop at the base of the aeciospore chain, rarely 1-celled, frequently 2- and 4-celled dividing crosswise; autumnal spores in separate sori, joined in chains, usually 1-celled (Figure 7). On **Astilbe**. Two species in the Far Eastern Territory,[2] Japan, and India. . . . . Pucciniostele Tranz. et Kom.[3]

[1] The Japanese genus **Miyagia** Miyabe is distinguished by the uredio- and teliospores enclosed in the elongate tubular peridia consisting of brown oblong cells; the fungus causes thick swellings on leaves, and the peridia enable ejection of the spores. It is doubtful whether it is an independent genus.

[2] [Divided in 1938 into the Maritime and Khabarovsk territories.]

[3] See L.I. Kursanov, N.I. Tseshinskaya, E.S. Klyushnikova, 1936.

(59)

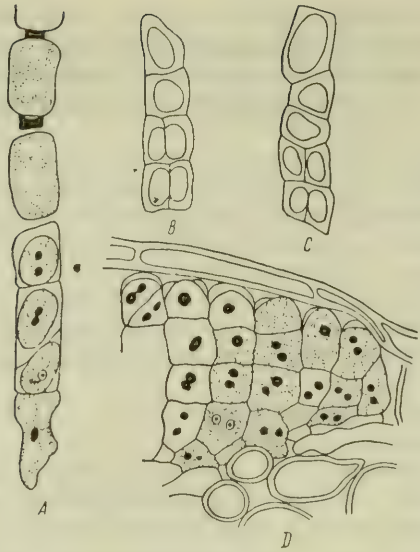


FIGURE 7. Pucciniostele mandschurica Diet.:

A — basal cell with elongate composite chain (at the top 3 aeciospores and intercalary cells, underneath 3 mother-cells of the primary teliospore); B, C — 2 chain fragments of the primary teliospore; D — margin of secondary telium. (After L.I. Kursanov, N.I. Tseshinskaya, E.S. Klyushnikova, 1936.)

RUST FUNGI AS INDICATORS OF KINSHIP OF THEIR HOSTS IN CONNECTION WITH THE PHYLOGENESIS OF RUST FUNGI

The specific parasitism of fungal species on related plants is sometimes instrumental in assessment of the relative kinship of the hosts through the similarity of the fungal species. We discussed this problem in the article "Rzhavchinnye griby v ikh otnoshenii k sistematike sosudistykh rastenii" ("Rust Fungi in Relation to the Taxonomy of Vascular Plants") (Tranzschel, 1927a), but since then a considerable amount of relevant material has accumulated, justifying our return to the subject.

In 1914, Dietel formulated the concept that rust fungi evolved... "closely parallel with the evolution of their hosts." In 1940 Dietel explained the same view differently: "The evolution of rust fungi and their transition to new host plants of other families apparently always proceeded in the sense of progressive development of the vascular plants. In other words: if any rust fungus has shown a tendency to carry over its development, or part of it, to another host not closely related to the former plant, it will never attack a plant older in geological age than the previous host, but always only those evolved in a more recent or in the same geological period."

Let us consider the opinions concerning the evolution of rust fungi and those data that led Dietel to the aforementioned views.

Two points should be taken into account in the evolution of rusts: the phylogeny of the taxonomic units and the development of pleomorphism and heteroecism. Between the years 1890 and the beginning of 1900, an animated discussion was engaged as to which spore-form represents the primary, and as to how the regular alternation of spore stages and heteroecism arose. Various and controversial opinions were voiced. This controversy was purely speculative, devoid of actual facts. Even now, when the number of rust genera (mainly on account of tropical forms with developmental cycles not properly known), has considerably increased, it is still impossible to solve this problem for all rust fungi. But, in relation to the better known genera distributed in the temperate zones of
61 Eurasia and North America, scientists have now reached the conclusion that the older types represent species with complete cycles of development and are, moreover, heteroecious; pleomorphism and heteroecism arose early in the adaptation of rust fungi, in their unknown ancestors. Rust fungi are apparently descendants of the parasitic **Auriculariaceae** or **Hypostomataceae**, parasites of mosses, ferns, and conifers. Gäuman designated the rust fungi as "living fossils," regarding them as very ancient. Further, we shall consider only well known Eurasian and North American genera.

In the aforementioned article (Tranzschel, 1927a) we formulated the concept that evolution proceeds from forms with teliospores concealed under the epidermis, unable to spread independently, not ejected from the host's tissue, through forms in which the telia has emerged to the surface of the leaf or stem of the plant by piercing the epidermis, while the teliospores are firmly attached to the substrate, and finally to forms in which the teliospores easily secede from the substrate and spread independently. From this aspect the genera of two families of rust fungi, **Melampsoraceae** and **Pucciniaceae**, will be further examined.

The majority of **Melampsoraceae** are heteroecious apart from one species of **Coleosporium** and several species of **Melampsora**. But in most genera species are also known which produce only teliospores (on conifers); the overwhelming majority of mycologists maintain that these species arose by omission of the aecial and uredial stages, and transition to development of teliospores on aecial hosts of heteroecious species (conifers); this transition was probably necessary since the basidiospores produced by teliospores can infect only aecial hosts of heteroecious species, and aecial hosts of species with a reduced cycle derived from them.

Of the heteroecious **Melampsoraceae**, apart from several species of **Melampsora**, the aecial hosts are represented by conifers — **Abietineae**. The most ancient genera among **Melampsoraceae** are considered to be **Uredinopsis**, **Milesia**, and **Hyalopsora**, in which no evident sori are formed by the teliospores developing either subepidermally or intraepidermally. In the former two genera the urediospores are devoid of pigment, which is apparently a primitive characteristic. All species of these genera are heteroecious, with aecia on **Abies**, and the uredio- and teliospores on ferns of the families **Polypodiaceae** and **Osmundaceae**. They are distributed mainly in eastern North America and in the Temperate Zone of eastern Asia, in regions of ancient flora, but hardly any of the species are common to both America and Asia, although the hosts are found in both hemispheres;

thus, entirely different species of Uredinopsis parasitize Dryopteris thelypteris on the two continents. Closely adjoining Uredinopsis are four genera (Pucciniastrum, Thekopsora, Calyptospora, and Melampsorella), usually with the teliospores still locked in the sori, the aecia on Abies, Picea, and Tsuga, and the uredio- and teliospores on Betulaceae (Corylus), Fagaceae (Castanea), Urticaceae (Boehmeria), Caryophyllaceae, Tiliaceae, Celastraceae, Onagraceae, Cornaceae, Styracaceae, Boraginaceae, Caprifoliaceae, Rubiaceae. The genus Melampsoridium has three species, their telia tightly closed, characteristic parasites of three genera of Betulaceae (Betula, Alnus, and Carpinus, passing from the latter also onto Corylus), and of Larix. The genus Cronartium, with uredia resembling those of the preceding genera, develops aecia on branches of Pinus, whereas the uredio- and teliospores develop on Fagaceae (mainly on Quercus, in North America and eastern Asia), and on Ribes; one species is plurivorous
62 in the uredio- and teliospore stages (the sole case known in Uredinales; among Pucciniaceae three species are known at present to be plurivorous in the aecial stage); this species develops on Ranunculaceae, Asclepiadaceae, and other families, and was found able to parasitize plants of foreign flora, as for example, Tropaeolum, Schizanthus, etc.; this species will be discussed at the end of the chapter. In species of genus Cronartium the teliospores are united in columns rising over the leaf surface, easily seceding, and probably liable to be carried away by various means. The genus Chrysomyxa, farther removed from the preceding and apparently an ancient genus, is associated with the genus Picea and evergreen plants of the families Ericaceae and Pirolaceae of the order Bicornes. One species is found on Empetrum. This host will be discussed later. Several species which develop only teliospores are encountered on Picea. The genus Coleosporium, in which true teliospores are replaced by basidiospores erroneously considered teliospores, may be regarded as primitive, but "simplified" would probably be more appropriate. Coleosporium is associated with Pinus in the aecial stage while the uredio- and teliospores develop on species of different families, chiefly Ranunculaceae, Scrophulariaceae, Campanulaceae, and Compositae. Likewise, species of Cronartium may pass onto plants of extraneous flora, being at the same time strictly specialized in relation to their main host, as for example, certain species of Campanula. One species of Coleosporium is autoecious; it develops aecia, uredia, and telia on Stevia, of the Compositae in Mexico. Only one species is known with teliospores on Pinus, in Siberia and North America. If the aecial hosts of Melampsoraceae are carefully examined, it is discovered that the most ancient genera develop uredio- and teliospores on ferns associated with Abies, then follow the genera with uredio- and teliospores on phanerogams, with aecia on Abies, Picea, Tsuga, Larix, and, finally, on Pinus. Paleobotanists maintain that Pinus is more ancient than other genera of Abietineae, but the fungi tell another story. As a last resort it may be agreed that contemporaneous rusts occur where all these conifers had already existed.[1]

[1] A certain indication of the time at which the rusts appeared in the Temperate Zone may be gained from the fact that rust fungi are unknown on many ancient plant families, such as, Marattiaceae, Gleicheniaceae, Lycopodiaceae, Equisetaceae, Cycadales, Ginkgoaceae, Taxaceae, Araucariaceae, Palmae, Platanaceae, Juglandaceae, Magnoliaceae, etc.

The evolution of genus **Melampsora** is particularly interesting. The primary species should be considered those with uredio- and teliospores on **Populus** and **Salix**, and aecia on **Larix**, **Pinus**, **Abies**, and **Tsuga**. Next follow species on **Populus** and **Salix** with aecia on **Angiospermae** (**Allium**, **Arum**, **Mercurialis**, **Chelidonium**, **Corydalis**, **Ribes**, **Saxifraga**, **Viola**, etc.). One species, like **Coleosporium** on **Stevia**, remained autoecious on **Salix**, and, finally, autoecious species developed on **Linum**, **Euphoria**, **Hypericum**, **Stellera**, **Apocynum**, etc. One species produces only teliospores on **Tsuga canadensis** in the northwestern U. S. A. and in Canada. Thus, of the family **Melampsoraceae** only the genus **Melampsora** comprises species with complete cycles, autoecious, not associated with conifers; according to this characteristic the genus **Melampsora** may be considered the most advanced of the family, ranging from species on **Salicaceae** and **Abietineae** to species developing all stages on a single angiospermous host.

As to the large family **Pucciniaceae** (comprising 15 tribes), we find that evolution has evidently followed several lines. Thus, one line is represented
63 by the apparently primitive genera in which the sori emerge through the stomata: **Desmella** (on ferns in South America), **Gerwasia** (on **Rubus** in Java), **Hemifleia** (on **Rubiaceae**, **Orchidaceae**, and representatives of other families in all tropical countries) and **Cystopsora** (on **Olea** in India); closely adjoining the latter is the genus **Zaghouania** (on **Phillyrea** in the Mediterranean region). The evolutional hives of tropical genera, still incompletely studied, are not altogether clear; for example, part of the **Pucciniosireae** have probably evolved from **Endophyllum** type forms, in which the teliospores correspond morphologically to aeciospores, but germinate into basidia. If we consider the better known genera of **Pucciniaceae**, from the North Temperate Zone, we find again the same path of evolution as that recorded in **Melampsoraceae**. In the larger genera **Puccinia** and **Uromyces**[1] (liable to be united), we consider as more primitive the species with telia permanently concealed under the epidermis, and teliospores on very short pedicels, the type of **Puccinia glumarum**. Then come the species in which the epidermis ruptures above the sori, and the teliospores are borne on more or less elongate, firm pedicels; the teliospores do not abandon the substrate, and the pedicels apparently become more brittle only in the spring; this is the type of **Puccinia graminis**.

The third type, considered by us more recent, comprises species with teliospores readily seceding from the pedicels, with pulverulent telia. In some species the sori are known to be of the second or third type, as in **Puccinia chrysosplenii**, in which compact hypophyllous sori develop from smooth, pale teliospores which germinate immediately, while later, on the upper side, pulverulent sori appear with darker teliospores delicately sculptured longitudinally; in **Puccinia saxifragae** we found only spores of the third type, quite similar to the spores of **P. chrysosplenii**.[2]

[1] The genus **Uromyces** in the true sense is indisputably phylophyletic; the complete parallelism between pairs of species was repeatedly demonstrated, and they were differentiated only by the 1- or 2-celled teliospores. Only the inexpediency of increasing the already excessively large number of species in the genus **Puccinia** prevented us from transferring all species of **Uromyces** to the genus **Puccinia**.

[2] The following is worthy of note: **Puccinia tranzschelii** produces teliospores with firm pedicels (second type) throughout its range of distribution from the Urals to Sakhalin, whereas in Kamchatka a specific form is found — f. **fragilipes** Jørst., with fragile pedicels (third type).

Among the species of the first and second types many are heteroecious, especially on Gramineae, Cyperaceae, Juncaceae, Hemerocallis, Veratrum, Iris, Rumex, etc. Among species of the third type fewer are heteroecious, parasitizing mainly Leguminosae, Polygonaceae, Capryophyllaceae, Veratrum, and Impatiens; among heteroecious grass parasites of the third type there are apparently only three species of Puccinia from North America, three from Eurasia, and two species of Uromyces from Soviet Central Asia. The first type is significantly less frequent on Cyperaceae than on Gramineae, and never reported on Carex. If we examine the genera of Pucciniaceae we observe that heteroecism is very frequent in the species Puccinia and Uromyces, and most probably in Nyssopsora, with uredio- and teliospores on Terebinthales, and with aecia on Umbelliflorae. A special branch is constituted by the heteroecious genera of Tranzschelia, Leucotelium, and Ochropsora with the uredio- and teliospores on Rosales, and aecia on Ranales; adjoining these is Cerotelium dicentrae with uredio- and teliospores on Laportea (Urticaceae), and aecia on Dicentra (Papaveraceae). Close to the genus Puccinia we find the heteroecious species
64 of Gymnosporangium with the aecia on Rosales (with one exception), and teliospores on Cupressaceae.

The genera Gymnosporangium and Nyssopsora should be regarded as highly advanced in their evolution. We know of no other heteroecious genera among Pucciniaceae. It may be stated with certainty that Phragmidieae, Uropyxis, and Ravenelia, which are classified high in the system of Pucciniaceae because in many of them special adaptations have evolved for the ejection or dissemination of teliospores, do not comprise heteroecious species. All Phragmidiaceae are associated with Rosales; Uropyxis and Ravenelia are associated mainly with Leguminosae. The genus Puccinia also comprises some groups of species with intricately built teliospores. Thus, in all species of Puccinia on Lycium and Grabowskia (Solanaceae), encountered in Palestine, southern Africa, and South and North America, the pedicels of teliospores swell considerably in water.[1] We may say that the higher the evolution of the genus (or of the group of species) the less chances there are of finding heteroecious species.

Examining the hosts of Uredinales we find that the primitive Uredinales of both families (Melampsoraceae and Pucciniaceae) parasitize ferns, whereas the more differentiated parasitize Leguminosae and Rosales. In the tribe Pucciniastreae (family Melampsoraceae) all species of three genera parasitize exclusively ferns, and none of the majority of genera

[1] The type of these species probably arose prior to the severance of the geographical distribution of Lycium, after which differentiation of parasites proceeded simultaneously with that of the Lycium species. The characteristic pedicels of teliospores in species of Puccinia on Lycium enabled us to reveal two cases of inaccurate determination of hosts. Arthur (1934, pp. 282, 283) described two species of Puccinia with characteristic inflated pedicels, presumably found on Suaeda intermedia Wats. (P. dondiae Arth.) and on Graya spinosa Moq. (P. grayiae Arth.). The host found for both fungi belongs to Chenopodiaceae. The excellent illustrations executed by Arthur's coworker, Cummins, reveal that P. grayiae is identical with P. globosipes Peck (p. 331) which parasitizes species of Lycium. In a letter to Prof. Arthur I expressed my assumption that the hosts of the two named species were incorrectly determined, and that they are represented by species of Lycium. Prof. Arthur confirmed my assumption; subsequent studies of leaf infestations proved that P. grayiae parasitizes Lycium andrewsii and is identical with P. globosipes, whereas P. dondiae is indeed a new species, but its host is Lycium californicum.

was found on Betulaceae or Fagaceae. In the tribe Cronartieae one species is associated with Quercus; in genus Melampsora the most typical species parasitize Salicaceae. All these genera comprise species which parasitize higher taxa of Angiospermae, but these species may be considered as produced by ulterior intrageneric development.

The discovery of new forms in the tropics, and especially the elucidation of their life cycle, will probably further clarify the phylogeny of rust genera. The simplest genus of Pucciniaeae — Desmella (on ferns) — was discovered only in 1918. The rapid increase in the number of genera of Uredinales is evident from the following data: in 1897 — 31 genera; in 1899 — 38; in 1928 — 102 genera[1]; the number of genera increases every year. We may point out that genera Ochropsora and Tranzschelia, united by Dietel on account of their related hosts, seem far apart from the morphological aspect; however, after we elucidated the biology of the cherry rusts, previously referred to Puccinia but constituting a new genus, Leucotelium in (1935), with three species, the gap between the two genera mentioned seemed to be filled by this new one.

65 From the aforementioned examples it is evident that certain rust genera or groups of species are associated with definite families or genera of hosts: the genera Uredinopsis, Milesia, and Hyalopsora on ferns and Abies; Melampsoridium on Betulaceae and Larix; Tranzschelia, Leucotelium, and Ochropsora on Rosales and Ranunculaceae; all 8 genera of Phragmidieae and the adjoining Gymnoconiae (with 2 genera) on Rosales.

Let us examine some genera of rust fungi in which the majority of species are parasitic on closely related hosts, but one or several species parasitize other, unrelated hosts.

In the genus Chrysomyxa all species so far known (about 15) are either heteroecious, with aecia on Picea, and uredio- and teliospores on Ericaceae and Pirolaceae (of the order Bicornes), or are represented by simplified forms with teliospores on Picea. The only exception is Chrysomyxa empetri. In this case the fungus presumably arose by passing through some species of Ericaceae ecologically close to Empetrum. But in an extensive study of the evolution of the Empetrum flowers Samuelson (1913) revealed that Empetrum should be included in Bicornes — Ericineae — even before this opinion was expressed by Agard, Gray, Solms-Laubach, and Bayon. Samuelson's opinion was confirmed by the presence of the parasites. We know two more cases in which the presence of the parasites indicated the direction in which the links should be looked for. All species of the genus Gymnosporangium with teliospores on Cupressaceae develop aecia on Rosaceae and Saxifragaceae (Rosales), while one species develops aecia on Myrica and Comptonia (Myricaceae). However, Hutchinson (1926) transferred Amentiferae from Rosales to Hamamelidaceae. In my opinion Salicaceae and Betulaceae are more ancient than Rosales, and Myricaceae are possibly related to Rosales, but special studies should be made in this direction. The genus Ravenelia, almost exclusively tropical, parasitizes Leguminosae, but two species, of Ravenelia and of the near-standing Nothoravenelia, (a more primitive Japano-Manchurian genus), parasitize Euphorbiaceae and Phyllanthoideae; is this not kinship?

[1] In 1953 — 128 genera. Note of V. F. Kuprewicz.

Turning to less doubtful correlations we find that Puccinia reaumuriae (on Tamaricaceae) and P. frankeniae (on Frankeniaceae) are almost identical, indicating the kinship of the two families as acknowledged by taxonomists.

Toona (Cedrela pr. p.) of the family Meliaceae, and Koelreuteria of the family Sapindaceae are hosts of very closely related species of the genus Nyssopsora, thus corroborating Wettstein's classification of these families in a single order, Terebinthales, whereas Angler maintains that Meliaceae belong to the order Geraniales, and Sapindaceae to Sapindales. Species of Nyssopsora were earlier included in the genus Triphragmium. Detailed studies of the species referred to this genus proved that it comprises three genera, their similarity based on convergent evolution. Triphragmium, stricto sensu, comprises parasites on Rosales (Rosaceae, and Astilbe of Saxifragaceae), and the genus Triphragmiopsis develops on Renales (Berberidaceae and Ranunculaceae). In these examples the morphological determination of the fungal species corroborates the difference between their hosts and the kinship between the hosts of each genus.

The subtribe Cichorieae-Cichoriinae of the family Compositae is artificial, comprising genera somewhat related and united only by the absence of pappi on the fruits. The secondary nature of this feature is evident even from the fact that the genus Centaurea includes species with
66 and without pappi. O. Hofman in a monograph on Compositae acknowledges that certain Cichoriinae constitute the links with the subtribes Leontodontinae and Crepidinae. The presence of parasites indicates which genera of Cichoriinae are related to genera from the other subtribe. Puccinia rhagadioli is very close to P. scorzonerae and P. tragopogi; P. litoralis infects species of Sonchus, but also of Cichorium; P. opizii develops aecia on Lactuca and Lampsana, and also on some species of Crepis, while it infects species of Sonchus.

O. Hofman included the genus Adenostyles, (occurring in the mountains of western Europe and Asia Minor) in the subtribe Adenostylinae (tribe Eupatorieae, family Compositae); in this subtribe the genus Adenostyles is the sole representative of the Old World flora in the midst of American genera; but many authors place this genus in the tribe Senecioneae, an approach supported by the presence of the parasites in western Europe on Adenostyles. One of these parasites, Uromyces cacaliae Unger was revealed by Ito in Sakhalin and the Kuril Islands and another, Puccinia expansa Link, is found in Europe, Asia, and America also on species of Senecio. Uromyces veratri breaks up into three races differentiated by the aecial hosts: Adenostyles and Homogyne in the West, and Cacalia in the East. Adenostyles is morphologically similar to species of Cacalia and some species of Senecio, and Linnaeus referred the species of Adenostyles to genus Cacalia.

O. Hofman included Xanthium, Iva, and other genera in the subtribe Ambrosiinae, tribe Heliantheae, whereas other authors, mostly American, conferred on this subtribe the position of a family — Ambrosiaceae. From our experience, Puccinia helianthi can infect Xanthium strumarium; in the USSR the fungus was several times found to pass readily from Xanthium to sunflower plants. In the U. S. A. fungi of this type are not found on Xanthium, but a very similar fungus on Iva xanthiifolia was encountered in six states, and described under the name Puccinia xanthiifoliae E. et E.

The parasitic fungi found on wild **Iva xanthiifolia** somewhere in the Ukraine, near Belaya Tserkov, were indistinguishable from **P. xanthiifoliae** and **P. helianthi**, and since introduction of the fungi together with the host from America seems less probable than passage of **P. helianthi** to **Iva**, we incline to adopt the latter explanation. **Helianthus** is referred to the subtribe **Verbesininae**. Fungi indistinguishable from **P. helianthi** were collected near Eisk and Rostov from plantations of the oleaginous plants **Guizotia abyssinica**; and here we probably have a case of **P. helianthi** parasitizing a new host — **Guizotia**, of the subtribe **Coreopsidinae**, tribe **Heliantheae**. The passage of **Puccinia helianthi** from the sunflower to **Xanthium** and its subsistence on **Iva** as naturally as on sunflower indicates that **Ambrosiinae** cannot be separated as a family and that their place in the system was correctly established by O. Hofman.

The fungus **Uromyces alsines** described by us on **Minuartia** (**Alsine**) **setacea** (from the Crimea) proved to be almost identical with **Uromyces scleranthi** Rostr. on **Scleranthus perennis** from the Leningrad Region, Denmark, and France, on **S. dichotomus** in Hungary, and on **S. diander** R. Br. in Australia. It remains to investigate whether the fungus can pass from **Minuartia** to **Scleranthus** and back. The identity of the **Uromyces** species mentioned and the similarity of habitats of **Scleranthus** and **Minuartia** species led us to assume that **Scleranthus** developed from **Minuartia** through loss of the petals and transformation of the pods into nuts. I later learned that the same view was formulated by Firchapper, in 1907, on the basis of morphological studies of the aforementioned species.

67 We shall now examine the instances in which the presence of parasites indicates the possibility of dividing a genus into several genera or sections.

The genus **Geum** is divided by taxonomists into two subgenera, **Eugeum** and **Sieversia**. Of the five sections of the first subgenus only two, **Orthuras** and **Oligocarpa**, are known to be parasitized by rusts, generally by **Phragmidium circumvallatum**, found on **Geum heterocarpum** and **G. kokanicum** in Spain and Soviet Central Asia. On species of the subgenus **Sieversia** another species of **Phragmidium** is known, from northern Japan. The necessity of uniting the two sections, **Orthurus** and **Oligocarpa**, was expressed by S. V. Yuzepchuk. It is possible that a division of the genus **Geum** into three genera will follow. In this connection it should be mentioned that **Phragmidium circumvallatum** was recently detected in the Northern Caucasus, in the Upper Park in Kislovodsk. A representative of the section **Orthurus** — **Geum speciosum** Albow — is found in the Caucasus only in Abkhazia. Presumably, in Kislovodsk either **Geum speciosum** or a new species of **Geum** is found. We have in our possession infected leaves considerably smaller than those of **Geum speciosum**. It would follow that all the specimens of this **Geum** species are concentrated in Kislovodsk.

Many botanists do not separate the genus **Ostericum** from the genus **Angelica**; but the species of **Puccinia** parasitizing them are quite different, and furthermore the parasite on **Ostericum** resembles the parasite on genus **Pimpinella**.

The genus **Hypochaeris** of the family **Compositae** has two sections: **Euhypochaeris** and **Achyrophorus**. The latter is considered by some authors an independent genus. In 1905, Bubák separated from **Puccinia hypochaeridis** Oud. (which should now be designated **P. hyoseridis** (Schum.) Liro)

on H. radicata L. and H. glabra (of section Euhypochaeris) a new species — Puccinia montivaga Bubák, on H. Uniflora Vill. (of section Achyrophorus). In the USSR, H. (Achyrophorus maculata of section Achyrophorus is common; the fungi parasitizing this species were found by us to belong to Puccinia montivaga. On Hypochaeris grandiflora Ledeb. the fungi resemble Puccinia hypochaeridis, not P. montivaga, although Hofman referred the host of the fungus to section Achyrophorus. However, de Candolle divided the genus Achyrophorus into two sections: Oreophila DC, to which is referred H. grandiflora under the name Achyrophorus aurantiacus DC, and section Phanoderis DC with A. maculatus Scop., and A. helveticus Scop. (= H. uniflora Vill.). Judging by the parasites, either the genus Hypochaeris should be divided into three equal sections, or the section Oreophila DC should be included in the genus Hypochaeris s. str.

As pointed out by R. Probst (1909), Puccinia hieracii (Schum.) Mart. should be divided according to the same criteria as P. hypochaeridis (the position of pores in urediospores) into two species: Puccinia hieracii s. str., on species of subgenus Archieracium, and P. piloselloidarum Probst on species of subgenus Pilosella. The constancy of the characteristic adopted by Probst for the separation of species requires, however, further verification. Examinations carried out at the herbarium of the Botanical Institute of AN SSSR generally corroborated Probst's report, except for two specimens on species of Hieracium (of subgenus Pilosella) in which the pores of urediospores of the primary uredia were not always located as expected.

Of great interest were the results obtained with two samples of fungi on Hieracium holeleion Maxim., from Manchuria; Puccinia hololeii m. proved to be a new species, clearly differentiated from the fungi on other species of Hieracium, and according to its characteristics close to the parasites of certain species of Lactuca. I happened to see a specimen of Hieracium
68 hololeion collected in the Far East, and I may say that with its general appearance and the pale faintly colored calathides this plant resembles Lactuca rather than Hieracium.

In Eurasia two species of Puccinia are found on species of genus Taraxacum: Puccinia taraxaci Plowr., which is very common indeed, and as widespread as Puccinia variabilis (Grev.) Plowr. is rare. I saw the latter in specimens from Pushkin (Leningrad Region), the Moscow Region (former Tula Province), the Voronezh Region, Kulikalon (Tadzhikistan) and Omsk; in Kiev P. variabilis was found on cultivated Taraxacum megalorrhizon Hand.-Maz.(=T. gymnanthum DC). This different distribution of the two parasites on Taraxacum may be explained by the fact that P. variabilis parasitizes only rare species of the polymorphous genus Taraxacum. It is suggested that mycologists collect, as far as possible, all flowering and fruiting specimens parasitized by the fungi, while florists and phanerogamists concentrate on specimens of Taraxacum on the leaves of which sparse groups of cup-shaped aecia or brownish-black sori may be found. In the work published together with Tranzschel (1927a) we indicated that the native fungi of the genus Uromyces parasitic on section Anisophyllum of genus Euphorbia (now acknowledged by many authors as a separate genus, Chamaesyce), divides into three closely related species: Uromyces proëminens Lév., on 11 species of Chamaesyce, U. tordillensis Speg., on 2 species, on which the urediospores show 4—6 (usually 5) pores, and U. euphorbiicola (Berk. et Curt.) m., on 5 species, the urediospores,

usually with 3 (2—4, rarely 5) pores. All 13 host plants of the first two species have naked fruits, whereas the 5 host species of the third rust species bear pilose fruits. I expressed the view that in the classification of species of **Chamaesyce** priority should be given to the character of the fruit surface; however, no specific value is accorded to this feature in the monograph of **Euphorbia** by Boissier, in connection with the division of the section **Anisophyllum**. In the third part of volume VII of "North American Flora" (1912), p. 260, Arthur mentions Uromyces **proëminens** on 25 species of **Chamaesyce** without acknowledging the species of **Uromyces** isolated by us; in "Manual of the Rusts of the United States and Canada" (1934) Arthur mentions this fungus on 20 species of **Chamaesyce**, referring our fungal species to varieties; 5 species of **Chamaesyce** reported in "North American Flora" are not listed in the "Manual" — the species of Mexico, Guatemala, and Nicaragua. Of the 20 hosts mentioned in the "Manual" 5 are designated as hosts of **U. proëminens euphorbiicola** (Tranz.); the fungi on two of these hosts have not been studied by us, nor reported in the above-mentioned work; they proved to have pilose fruits. Fifteen species of **Chamaesyce** are listed in the "Manual" as hosts of U. **proëminens typicus**; the fungi on 7 of them were not investigated by us; of these 7 hosts, 5 bear naked fruits, and only **Chamaesyce polycarpa** Benth. and C. **arizonica** Engelm. produce pilose fruits (**capsula hirtula, c. pilosa**). Thus, U. **proëminens typicus** (including **U. tordillensis** Speg.) is known to parasitize 19 hosts, of which only two have pilose fruits, whereas U. **euphorbiicola** is known on 7 species of **Chamaesyce**, all of which bear pilose fruits. It is possible, however, that either the hosts (with the exception of two species), or the fungi parasitizing them were not accurately determined.

I shall not analyze here in detail the relationship between species of **Euphorbia** (subgenus or section **Tithymalus**) and their parasites of the genus **Melampsora**, which were earlier discussed (Tranzschel, 1927a). These species of **Melampsora** form a "gradual series," from forms with
69 elongate teliospores to almost cubical, whereby no clear-cut boundary is perceptible between the forms. A careful examination of the fungal associations with individual species of the **Euphorbia** subsections reveals that forms with more elongate teliospores, **Melampsora gelmii** Bres., parasitize species of subsections **Esulae** and **Pachycladae**, while forms with shorter teliospores, **M. euphorbiae-dulcis** Otth., parasitize on subsection **Galarrhoei**. Among the forms with medium-sized teliospores, **M. helioscopiae** Wint. parasitizes species of subsection **Galarrhoei**, and **M. euphorbiae-gerardianae** W. Müller and **M. euphorbiae** Cast. (= **M. cyparissiae** W. Müller), species of subsection **Esulae**.

The genus **Trachyspora** Fuckel (**Uromyces** sp. auct.) parasitizes on genus **Alchimilla**, which comprises numerous apogamic species differentiated with difficulty by taxonomists, while the fungi are excellently distinguished in them. **Trachyspora melospora** (Therry) Tranz. (Tranzschel, 1914a) is found in the mountains of Central Europe on **Alchimilla alpina** L. and **A. pentaphylla** L., and in the Caucasus on **A. sericea** Willd. The studies of E. Fisher indicate that in the Alps the above-named fungi parasitize only the subspecies **A. hoppeana** Buser and do not infect the subspecies **A. eualpina** Asch. et Gr. (= **A. saxatilis** Buser); this explains why **Trachyspora melospora** is not found in Arctic Europe, where only the subspecies **Alchimilla alpina** is encountered. **Trachyspora alchimillae**

(Pers.) Fuckel parasitizes **Alchimilla vulgaris** auct. It develops mostly on A. **pastoralis** Buser both in western Europe and in the Leningrad Region. Our observations and experimental infections at Staryi Petergof [Petrodvorets], near Leningrad indicate that of 10 species of **Alchimilla** development of **Trachyspora alchimillae** may succeed only on A. **pastoralis** Buser, on the closely related species A. **propinqua** Lindb. f., and (possibly) on A. **strigulosa** Buser. Experiments carried out by E. Fisher indicate that in Switzerland the fungi may pass from A. **pastoralis** Buser and A. **crinita** Buser (**Vulgares**) also onto A. **vetteri** (**Pubescentes**) and A. **splendens** Christ. (**Splendentes**), without attacking A. **micans** Bus. (**Vulgares**), A. **speciosa** Bus. (**Vulgares**), A. **acutiloba** Stev. (**Calycinae**) and A. **fissa** G. et Sch. Within the USSR **Trachyspora alchimillae** is found even on A. **erythropus** Juz. (?), A. **taurica** Juz., A. **jailae** Juz., A. **conglobata** Lindb. f. (in the former Northern Territory; it was not infected near Leningrad), A. **sibirica** Samelis, A. **retropilosa** Juz., A. **glomerulans** Buser, and A. **murbeckiana** Buser (close to A. **acutidens** Buser; not infected in the vicinity of Leningrad). It may be assumed that **Trachyspora alchimillae** comprises several biological races.

Uromyces fragilipes Tranz. was collected on only two occasions from the Ashkhabad District: once on **Eremopyrum buonapartis** (Spr.) Bornm. (= **Agropyrum squarrosum** Link), and the second time on weedy **Secale cereale** L. The kinship of the genera **Eremopyrum** and **Secale** indicated by S. A. Nevski (1933)[1] is corroborated by these finds.

It follows from the aforesaid that although the classification of rusts is generally greatly helped by the taxonomy of vascular plants, in some cases the fungi may prove instrumental in the classification of higher plants. However, this correlation between rust fungi and hosts cannot always be established, for in some cases the rust fungi might pass from their primary hosts to other plants, not always closely related. Particularly puzzling is the rather rare occurrence of "plurivorous" rust fungi, i.e.,
70 infection by certain rust species of plants belonging to quite different families. Thus, **Cronartium flaccidum** (= C. **asclepiadeum**) with aecia on pines can develop uredio- and teliospores in wild species of **Vincetoxicum**, **Paeonia**, and **Pedicularis**, and also on many genera of garden plants: **Asclepias, Grammatocarpus, Impatiens** (I. **balsamina**), **Nemesia, Ruellia, Tropaeolum, Verbena**; this is the sole species of rust fungi with various hosts for the uredio- and teliospore stages. Several species are plurivorous in the aecial stage. **Puccinia subnitens** with uredio- and teliospores on the grass **Distichlis spicata**, in North America, can develop aecia on representatives of 24 families. **Puccinia isiacae** on **Phragmites**, which ranges from Algeria, in the Mediterranean region, to Soviet Central Asia, is associated with representatives of 15 families through the aecial stage. We proved (Tranzschel, 1935a) that **Puccinia cynodontis** on **Cynodon**, with approximately the same range as P. **isiacae**, but also well known in warmer countries of North and South America and in Japan, can develop aecia on representatives of 6 families, but further experiments will most probably reveal more. In my article on **Puccinia cynodontis** (Tranzschel, 1935a)

[1] However, it should be mentioned that according to the studies of Prof. N. N. Lavrov the blight fungus in the germ of **Eremopyrum triticeum** (Gaertn.) Nevski (= **Agropyrum prostratum** P. B.) should be referred to the parasitic species of **Agropyrum**, i.e., to **Tilletia controversa** J. Kühn, and not to **T. secalis** J. Kühn.

I was inclined to regard the plurivorous property as a secondary phenomenon; now I would like to clarify this concept. Plurivorous species have not yet succeeded in elaborating a narrow specialization, as is evident from their easy transition to plants of foreign flora. However, certain indications of specialization have been noted. **Puccinia isiacae** parasitizes **Veronica arvensis** and **Galeopsis tetrahit** but does not infect **Veronica serpyllifolia** and **Galeopsis speciosa**; **Puccinia cynodontis** infects **Valerianella morisonii** but not **Valerianella olitoris**. By increasing the number of hosts the plurivorous species divide into specialized races; thus, the initially plurivorous **Puccinia sessilis** s. l. on **Phalaris arundinacea** has specialized in recent times into a series of subspecies differentiated by their aecia: **a** — on **Allium**, **b** — on **Arum**, **c** — on **Orchidaceae**, **d** — on **Iris**, **e** — on **Leucojum**, f — on **Liliaceae** — **Polygonateae** — **Convallarieae** — **Parideae**. The latter subspecies has further ramified into races which have specialized on **Convalleria**, or on **Paris**, while the primary subspecies **e** infects both these genera and many others. At the same time specialization of subspecies **b** and **d** is less pronounced (Mayor, 1933). Subspecies **b**, apart from the primary host — **Arum maculatum** — can infect, though slightly, **Allium ursinum**, on which aecia develop, whereas in experimental infections on **Convallaria** and **Polygonatum**, the hosts of subspecies **f**, only spermagonia developed. Subspecies **a**, apart from the primary host — **Allium ursinum** — easily developed aecia also on **Paris** and **Polygonatum** (**f**), whereas on **Arum** (**b**) and **Convallaria** (**f**) development ceased with the production of spermagonia. Subspecies **b** proved to be strictly specialized.

GEOGRAPHICAL DISTRIBUTION OF RUST FUNGI

The geographical distribution of rust fungi is determined first and foremost by the distribution of their hosts. In view of the generally accepted principle that evolution of rust fungi proceeded concomitantly with that of their hosts, it is not surprising that with the discontinued distribution areas of higher-plant genera the respective parasites were also frequently separated, spreading on related hosts in identical or parent species very remote from each other. Thus, for example, **Puccinia Thuemeniana** Voss. was long since known on **Myricaria germanica** only in
71 a certain valley in southern Tyrol; at length it was found in one place in Romania, and recently was reported from the Altai and Sayans on **Myricaria dahurica**. **Phragmidium circumvallatum** occurs on species of **Geum** of the sections **Orthurus** and **Oligocarpa** in Spain, the Caucasus, and Central Asia. Species of **Puccinia**, not identical but of a similar type, are found on species of **Lycium** and **Grabowskia** (**Solanaceae**) in Palestine, southern Africa, North and South America (Tranzschel, 1935a).

Nevertheless, in certain cases the geographical distribution of rust fungi is obviously not correlated with the distribution of their hosts. Thus, **Puccinia punctiformis** is found on species of **Rumex** in western North America (to Mexico), and in Asia from Kamchatka and Japan to eastern and western Siberia, but does not spread farther westward although one of its hosts, **Rumex aquaticus**, is widely distributed in Europe too. The ancient flora of eastern Asia and of eastern and part of western North America

are particularly rich in species of certain genera of rust fungi. In these regions numerous species of genera are encountered which, in my opinion, are ancient, such as **Uredinopsis**, **Milesia**, **Hyalopsora** (on ferns), and **Pucciniastrum**. In Europe their number is comparatively low. It is interesting that in the USSR most of the fern parasites are in the southern regions of the Far Eastern Territory and along the Black Sea coast of the Caucasus; they are almost completely absent in Siberia and the Urals, although perhaps their plain appearance prevents their detection there. **Pucciniastrum coryli**, frequent in eastern Asia, is nowhere found on species of **Corylus**; occurrence of this fungus in western Transcaucasia reported by Jaczewski in "Osnovy mikologii" (Fundamentals of Mycology) (p. 825) was not confirmed; the samples shown to me by V. Siemaszko seemed to be of **Melampsoridium carpini** on **Corylus**.

Many authors have repeatedly noted that in the Arctic regions and on high mountains a high percentage of **Micro-Uredinales** develop only teliospores. Most scientists agree that the **Micro-Uredinales** have evolved from macrocyclic genera (mainly heteroecious) by loss of the other spore stages. The reduction of stages probably took place (by selective mutation ?) as a consequence of the shorter growth season. Of these **Micro-Uredinales** some Arctic-Alpine species have narrower distribution areas than their hosts. Thus, **Puccinia trollii** on species of **Trollius** occurs in northern Scandinavia, in the USSR (in the [former] Murmansk "okrug" [Subregion], in Karelia, and once reported from Leningrad Region on clint in Ropsha), and also in the Alps and Altai, whereas **Trollius** ranges in the plains of Europe and is found even farther south. Two species of **Micro-Puccinia** on **Geranium silvaticum** and on other species of **Geranium** — **P. léveillei** and **P. morthieri** — are both Arctic-Alpine; **P. morthieri**, not reported from America, is spreading in the plain of Leningrad Region as far as the Volkhov and Luga rivers, **P. léveillei** is found in northern Scandinavia, Murmansk Subregion, and Karelia, Northern Urals, Yakutia, Kamchatka, Bering Island, Alaska, mountains of western North America, and in Chile; in the Alps, Altai, mountains of Central Asia, the Himalayas; in the Caucasus the fungus is found only in the Kuba and Shemakha districts of Azerbaijan, and in Erevan (Armenia).

Macrocyclic species are known from which many of the **Micro-Uredinales** have evolved through reduction of the cycle. **P. morthieri** is derived by reduction of the cycle from **P. polygoniamphibii**, which is widespread in Europe, Asia, North and Central America, and Africa, and it is not surprising that the microspecies is less widespread than the original macrocyclic species. We are more puzzled by **P. léveillei**. There is every
72 reason to assume that it is related to the macrocyclic species **P. monticola**, at present encountered in only a few places on the mountains of Soviet Central Asia. Such a narrow distribution of the macrocyclic species and wide distribution of the microspecies is rather hard to explain.

Puccinia ornata (microspecies) on species of **Rumex** is encountered in North America along the U. S. A.-Canadian border, from the Atlantic Ocean to the Rocky Mountains. It is found on **Rumex aquatica** only in the Tara District (Omsk Region) and near Khalturin (Kirov Region). Corresponding to this microspecies is the widespread macrocyclic form **Puccinia phragmitis** on reeds (**Phragmites**). Such a severance from the American habitat of **Puccinia ornata** in the Old World might be explained — if

specimens are not found in intermediate sites — by the development of this microspecies in several parts of the world, through reduction from the macrocyclic species.

Among the microspecies we should mention **Puccinia mertensiae** and **P. retecta** found in the Rocky Mountains in North America and in the mountains of Soviet Central Asia. **Chrysomyxa weirii** on **Picea schrenkiana**, originally reported from the northeastern mountain ranges of North America, spreading also in the Allegheny Mountains of the southwestern U.S.A., is encountered in Alma-Ata. The same spruce species in Alma-Ata is parasitized by **Chrysomyxa deformans**, which until recently was known only in the Himalayas. **Coleosporium (Gallowaja) pinicola** is found on **Pinus virginiana** in the eastern states of North America; on **Pinus sibirica** in Asia, in the Omsk Region and the Sayans; on **Pinus pumila** in Kamchatka. Uncharacteristic aecia on **Erotia** are found in western North America from Washington State to New Mexico, and in the USSR in the Kuibyshev Region, the Bashkir ASSR, and Kazakhstan. In America these aecia are connected with **Puccinia burnetti** on **Oryzopsis hymenoides** (possibly also on **Stipa comata**). In the USSR **P. burnetti** is absent and no connection was established between the aecia on **Erotia** and the uredio- and teliospores on grasses (possibly **Stipa capillata**).

The distribution of **Phragmidium kamtschatkae** (with spermagonia and teliospores) is interesting. This species is not found in America. Its distribution ranges from Kamchatka to the [former] Ussuri Region throughout Siberia and southward to Semipalatinsk, and in Europe to Karelia and eastern Finland; it is also common in the mountains of Soviet Central Asia and in the Himalayas. In Siberia this species parasitizes mainly **Rosa acicularis**, and farther west it also spreads on **Rosa cinnamomea**, but the fungus lags behind the spreading of this wild rose in the South and West.

The range of the rootbeet **Uromyces betae** is apparently determined by climatic conditions. It is frequently encountered in the fields of western Europe and rarely in the USSR. We have seen specimens only in the Vinnitsa Region of the Ukrainian SSR; inquiries made in the area revealed that the rusts occasionally appear (drifting in ?) but do not last. **Uromyces valerianae** is frequent in western Europe, and found in Transcaucasia (probably a special subspecies) on cultivated **Valeriana** in the Mogilev nurseries); the uredial stage was once reported from the Kirov Region, on the Kama River, in the Omutninsk District.

As is evident from the examples adduced apart from the species ranging from western Europe throughout the Temperate Zone of Asia and, in part, reaching America, and numerous species common in the Soviet Far East and Japan, a series of species earlier known only in America or in the
73 Himalayas occur in the USSR, some of them quite unexpected. In the elucidation of the distribution of rusts it should be recalled that rust fungi are a very ancient group, having probably appeared at the end of the Cretaceous (although their fossil remnants are doubtful), and that their distribution is linked with the history and evolution of their hosts. In my opinion the rust fungi were hardly ever in danger of extinction. As parasites, they depended upon the evolution of their hosts and rarely lagged behind the distribution of the latter. For example, **Patrinia sibirica** is widespread in Siberia, from Altai to Yakutia and northern Mongolia, and

in relict forms it occurs in the Southern Urals; the species **Puccinia muraschkinskii**[1] described by us on this plant from Altai was collected in Bashkiria — also a severed area of distribution of the host. However, in many cases the discontinued distribution — and that of microspecies in particular — may be correlated with independent species evolved from a common precursor. Most scientists now agree that microspecies have evolved from macrocyclic species by reduction of spore stages, although the respective macrocylic form is not always known; from the examples given, **Puccinia ornata, Chrysomyxa weirii, Coleosporium pinicola,** and possibly other microspecies may be considered as polytopically evolved.

It remains to discuss the drift of rust fungi. The best known example is **Puccinia malvacearum** Montg. Described in South America, in 1852, it appeared in Australia, in 1857, was carried over to Europe (in Spain), in 1869, and rapidly spread throughout Europe, appearing in Russia in 1892 on hollyhocks of the Botanical Garden in St. Petersburg, whence it spread on numerous wild representatives of **Malvaceae**, especially in the Ukraine, the Caucasus, and Siberia. In the last two decades two American rusts have spread in western Europe on garden plants. **Cumminsiella sanguinea** (Peck) Arth. (= **Uropyxis mirabilissima** Magn.) ranging in the western states of North America on species of **Berberis**, mainly on species of subgenus **Mahonia**, appeared in 1922, in garden thickets of **Mahonia aquifolium** in Scotland, and is now found almost throughout Central and northern Europe, spreading to Riga and to Roshchina (formerly Raivola, between Leningrad and Vyborg, on the Finnish railroad) (Poverlein, 1930).

A third American species recently carried over to Europe is the rust of the cultivated snapdragon **Puccinia antirrhini** Diet. et Holw. (Arthur, 1929). First detected in California on the European species **Antirrhinum majus** in 1879, and described from there in 1897, the fungus spread in the neighboring states. In 1913 it was already recorded in Chicago, whence it rapidly reached the shores of the Atlantic Ocean, spreading northward to southern Canada and southward as far as the Gulf of Mexico; in 1922, the fungus was found also in the Bermuda Islands. In Europe, it was recorded in France in 1931, and in 1934 it spread everywhere in France, except in the extreme south. Through 1933 and 1934 the fungus became widespread in southern England. In 1934 the fungus was found in Denmark and Germany (Cologne); in the beginning of 1935 it was already widely disseminated in Germany (Poverlein, 1935). In the same year the fungus was detected in Switzerland, in 1936 in Romania, and in 1937 in the USSR.

The rust of chrysanthemum, **Puccinia chrysanthemi** Roze., drifted in from Japan into Europe (in 1895), the U. S. A. (in 1896), Australia and New Zealand (in 1904). The rust of pinks (**Dianthus**), **Uromyces caryophyllinus** Winter, spread throughout the world together with the cultivated plant.

74 The fate of the currant rust, **Cronartium ribicola**, is interesting. This fungus was first recorded in Estonia, in 1855, with the aecial stage on white pines, and uredial and telial stages on currants. Twenty years later it was known in Finland, Denmark, and Germany, rapidly spreading throughout Europe. At length, we succeeded in proving that this fungus settles on **Pinus sibirica**, which provides the primary host for the aecial stage and, consequently, that this fungus is a newcomer to Europe from eastern

[1] A. Jaczewski (1933, p. 814) confused this species with the Japanese Puccinia patrinii.

Europe and Siberia. As the fungus was found in the Alps on **Pinus cembra** it might have been there as a component of the primordial flora, but this seems rather improbable. In America, **Cronartium ribicola** was unknown for a long time in the extensive forests of white pine but was probably introduced, in 1908, together with the white pine seedlings. The Americans fought this parasite vigorously, exterminating the currant species in the forests, but, to my knowledge, they failed to control it.

Arthur (1929, p. 174) compiled a list of 41 species of rust fungi introduced in North America.

The rust of the coffee shrub **Hemileia vastatrix** of African origin was imported in Ceylon, where in 1868 it developed extensively and spread eastward to the Samoa Islands. The fungus has not reached the coffee zone in America.

Recently, besides **Cronartium ribicola**, **Puccinia komarovii** began to spread westward within the Soviet Union, on **Impatiens parviflora**. From its original habitat, ranging from the mountains of Soviet Central Asia to the southwestern Altai, this plant has spread westward through botanical gardens as a kind of weed. The fungus **P. komarovii** is found in Soviet Central Asia in Tadzhikistan, Uzbekistan, Kirghizia, Kazakhstan to the southwestern Altai. From 1921 until recently the fungus was repeatedly found in the Kiev Botanical Garden. In 1933 it was found in the vicinity of Berlin. Before 1935 it was already recorded in Germany from 7 localities in Brandenburg Province, 6 in Silesia, and from one each in Hesse, Baden, and Bavaria. In 1935 (Sidow, 1935) **P. komarovii** was detected in Poland, in 1936 — in Estonia. In Leningrad, where **Impatiens parviflora** grows abundantly in the garden of the Botanical Institute of AN SSSR, the fungus was found in 1946. If the introduction of fungi on cultivated plants can be explained by the import of diseased plants or graftings, the import of fungi on annual weeds cannot be so easily explained, especially in view of the vast expanse separating the original habitat of the fungi from the site of their colonization. Apparently, colonization proceeded by means of seeds mixed with fungus-infected leaves, but it is doubtful whether this explains the rapid spread of the fungus over great distances such as those observed in Germany.

It is impossible to give statistical data for the comparison of the rust flora of the USSR with that of other countries because the amplitude of species is differently evaluated by different authors. The flora of rust fungi of the Soviet Union is quite well known at present, although there is no doubt that entirely new species might still be discovered in addition to species from adjoining countries. New species may be expected particularly in the mountains of Soviet Central Asia, the Arctic regions, and the Soviet Far East. Of the species encountered in western Europe we may expect to find in the western USSR such species as **Puccinia chondrillae** on
75 **Lactuca muralis**, **Uromyces phyteumatum** on **Phyteuma spicatum**, **Melampsora vernalis** on **Saxifraga granulata**, etc. In the Soviet Far East new species might be expected, especially from Japan. In the "Obzor rzhavchinnykh gribov SSSR" (Conspectus Uredinalium URSS) (1939)) we presented 915 species. Approximately 213 additional species might occur in the USSR within the limits of probability and these were indicated in the "Conspectus" as expectable. However, it should be mentioned that several North American species of the ancient rust fungi parasitic on

ferns, in North America, Japan, and the Far Eastern Territory, do not occur in eastern Asia on **Onoclea sensibilis**, (although they were specially searched for in Japan), nor on species of **Osmunda**, etc.; a species of the genus **Uredinopsis** widespread on **Dryopteris thelypteris** in western North America is not found in Asia, but on the same host a quite different species of **Uredinopsis** is widespread in eastern Asia. In expanse and degree of knowledge the rust flora of the USSR can be compared only with that of North America, i.e., of Canada and the United States (Table 2).

TABLE 2. Comparative number of genera and species of rust fungi in the USSR and North America (U.S.A. and Canada)

	USSR		Expected in the USSR	U.S.A. and Canada	
	genera	species		genera	species
Melampsoraceae					
Number of genera	14	—	—	15	—
Number of species	—	148	41	—	90
" " *Peridermium*	—	—	—	—	4
Pucciniaceae					
Number of genera	24	—	—	22	—
Number of species *Uromyces*	—	141	21	—	120
" " " *Puccinia*	—	500	113	—	410
" " " remaining genera	—	63	24	—	117
" " " *Aecidium*	—	63	14	—	38
Total	38	915	213	37	779
Without *Aecidium* and *Peridermium*	—	852	199	—	741

A list of rust fungi was recently published by Arthur in his "Manual," but since the author adopted the pure morphological approach the biological species established by us have been ignored. We have slightly modified the "Manual," subdividing the morphological species in order to achieve comparable data.

Tables 3 and 4 show the number of rust species in the individual genera in the two areas compared, and also the number of species in the largest genera, **Puccinia** and **Uromyces**, according to the families of their host plants.

If we compare the composition of the USSR flora with that of North America (Table 3), we find that in the USSR there are 148 genera of **Melampsoraceae** and in North America 94. The great number of species
78 in the USSR is mainly due to the number of species of **Melampsora** (35 versus 10) and **Coleosporium** (28 versus 22; in America no species of this genus parasitizes **Ranunculaceae**), and also to the abundance of species of this family in the Far East, where additional Japanese species might be expected. Genus **Chnoopsora** is absent in America (present in the Soviet Far East), and the genus **Phakopsora** is absent in the USSR; of this genus, confined almost exclusively to southeast Asia, from India to Japan, one species (on grapevine), is found in America; one of the Japanese species,
79 **Phakopsora artemisiae-japonicae**, may be expected on **Compositae** in the Soviet Far East. The genus **Bubakia**, related to **Phakopsora**, parasitizes species of **Croton** in America; **Bubakia** is not found in the USSR. Apart from the large genera **Puccinia** and **Uromyces** there are in the USSR 63 species of the family **Pucciniaceae**, and in North America 117 species.

(76) TABLE 3. Comparative number of species in the genera of rust fungi in the USSR and North America (U.S.A. and Canada)

	USSR		U.S.A. and Canada	Total of known species
	found	expected		
Melampsoraceae				
Uredinopsis	10	7	5	25
Hyalopsora	3	4	3	9
Milesia	12	7	8	51
Melampsorella	2	—	1	2
Thekopsora	8	1	4	15
Calyptospora	1	—	—	1
Pucciniastrum	10	3	7	33
Melampsoridium	4	—	3	4
Phakopsora (incl. *Physopella*)	—	3	1	30
Cronartium	6	1	7	20
Chrysomyxa	13	2	12	20
Coleosporium	28	3	22	80
Gallowaya	1	—	1	2
Melampsora (heteroicae)	35	3	10	80
M. (autoicae)	12	3	5	—
Caeoma	—	3	—	15
Chnoopsora	1	—	—	3
Bubakia	—	—	1	10
Uredo	2	1	—	exceeding 500
Peridermium	—	—	4	20
Pucciniaceae				
Zaghouania	—	1	—	1
Ochropsora	1	—	—	3
Aplospora	1	—	1	2
Cerotelium	1	—	2	20
Leucotelium	1	2	—	3
Tranzschelia	4	—	7	7
Trachyspora	2	—	1	4
Uredo nervicola	1	—	—	—
Gymnoconia (incl. *Kunkelia*)	1	—	2	3
Kuehneola	1	1	2	5
Mainsia	—	—	1	15
Frommea	1	—	2	2
Phragmotelium	1	—	—	10
Phragmidium	23	5	20	60
Xenodochus	1	1	2	2
Triphragmium	3	1	1	4
Uropyxis	1	—	4	15
Cumminsiella	—	1	3	4
Phragmopyxis	—	—	1	3
Pileolaria	1	—	4	15
Triphragmiopsis	1	1	—	2
Nyssopsora	1	1	2	8
Ravenelia	—	—	27	25
Nothoravenelia	1	—	—	2
Gymnosporangium	11	6	32	50
Blastospora	—	1	—	2
(77) *Uromyces* *	141	21	120	exceeding 600
Puccinia *	500	113	410	exceeding 1800
Schroeteriaster	—	1	—	1
Endophyllum	2	2	2	15
Baeodromus	1	—	1	5
Pucciniostele	1	—	—	5
Caeoma sedi	1	—	—	—
Aecidium	63	14	38	exceeding 600
	915	213	779	

* The number of species of Uromyces and Puccinia is indicated according to data of 1955; of the other genera – 1938. – V.F. Kuprewicz.

(78)

TABLE 4. Comparative number of species of **Puccinia** and **Uromyces** according to the families of host plants in the USSR and North America (U.S.A. and Canada)

	Uromyces			Puccinia		
	USSR		U.S.A. and Canada	USSR		U.S.A. and Canada
	found	expected		found	expected	
Sparganiaceae	—	—	1	—	—	—
Gramineae	14	2	22	81	21	104
Cyperaceae	3	—	6	37	8	36
Araceae	—	1	2	—	—	—
Commelinaceae	—	1	1	—	—	—
Pontederiaceae	—	—	1	—	—	—
Juncaceae	1	1	3	4	4	2
Liliaceae	10	2	10	19	4	17
Amaryllidaceae	—	—	1	—	2	2
Dioscoreaceae	—	—	—	1	—	—
Iridaceae	1	—	2	3	1	1
Orchidaceae	—	—	—	—	—	1
Urticaceae	—	—	—	1	—	—
Santalaceae	—	—	—	4	—	1
Aristolochiaceae	—	—	—	2	—	1
Polygonaceae	4	—	3	20	2	10
Chenopodiaceae	8	1	3	—	1	2
Amarantaceae	—	—	—	—	—	1
Phytolaccaceae	—	—	—	—	—	1
Portulacaceae	—	—	3	1	—	2
Caryophyllaceae	10	3	4	3	—	2
Ranunculaceae	3	—	2	17	5	12
Berberidaceae	1	1	—	—	—	1
Papaveraceae (Fumarioideae)	—	—	—	—	—	1
Cruciferae	—	—	—	12	1	10
Crassulaceae	—	—	—	1	2	2
Saxifragaceae	—	—	—	9	5	7
Rosaceae	—	—	—	1	—	3
Leguminosae	49	3	31	1	1	2
Geraniaceae	2	1	1	2	—	1
Oxalidaceae	—	—	—	—	—	1
Polygalaceae	—	—	—	—	—	1
Euphorbiaceae	15	—	9	—	—	—
Buxaceae	—	—	—	1	—	—
Balsaminaceae	—	—	—	2	—	1
Rhamnaceae	—	—	—	1	—	1
Malvaceae	—	—	—	2	—	4
Guttiferae (Hypericoideae)	—	—	1	—	—	—
Frankeniaceae	—	—	—	1	—	—
Tamaricaceae	—	—	—	2	—	—
Violaceae	—	—	—	4	—	5
Onagraceae	—	—	1	5	1	8
Helorrhagidaceae	—	—	—	—	—	1
Araliaceae	—	—	—	—	1	1
Umbelliferae	2	—	1	57	13	19
Cornaceae	—	—	—	—	1	1
Primulaceae	—	—	1	3	2	4
Plumbaginaceae	3	—	2	—	—	—
Oleaceae	—	—	—	1	—	—
Gentianaceae	—	1	1	3	—	3
Apocynaceae	—	—	—	2	—	1
Asclepiadaceae	—	—	—	—	—	2
Convolvulaceae	—	—	—	2	—	5
Polemoniaceae	—	—	—	2	—	6
Hydrophyllaceae	—	—	—	—	—	3
Boraginaceae	1	—	—	3	1	2
Verbenaceae	—	—	—	—	—	2
Labiatae	—	—	—	17	3	12
Solanaceae	—	—	—	—	—	6
Scrophulariaceae	2	—	—	6	2	14
Acanthaceae	—	—	1	—	—	3
Globulariaceae	—	—	—	1	—	—
Plantaginaceae	—	—	—	—	—	1
Rubiaceae	—	1	1	18	2	6
Caprifoliaceae	—	—	—	1	—	2
Adoxaceae	—	—	—	2	—	1
Valerianaceae	1	—	—	2	—	1
Campanulaceae	—	2	—	2	3	2
Compositae	2	1	6	100	27	70
	132	21	120	459	113	410

The greater number of species in North America is explained by the presence of 27 species of the genus **Ravenelia**, which occurs mainly in the tropical and subtropical countries of America, Asia, and Africa; in the USSR the genus **Ravenelia** is absent, and it is replaced in the Soviet Far East by one species of the related genus **Nothoravenelia** which is absent in America. **Gymnosporangium** is represented in America by 32 species, and in the USSR by 11 species; experimental infections with the species of this genus in the mountains of Soviet Central Asia, on species of **Juniperus** and **Pomaceae**, showed that their number might increase in the USSR. The majority of genera common to both the USSR and America are represented in America by more species, whereas the American genera **Cumminsiella** and **Phragmopyxis** are absent in the USSR. The East Asian genera **Leucotelium** (one species in southwestern Europe), **Phragmotelium**, **Triphragmiopsis** (one rare species in western Europe), **Nothoravenelia**, and **Pucciniostele** (encountered also in India) are not found in America, and neither is **Ochropsora**, characteristic of Europe and eastern Asia.

We shall now analyze the larger genera, **Puccinia** and **Uromyces** (Table 4). It should be stated that since the genus **Uromyces** is of polyphyletic origin it should not be retained; all biological and morphological characteristics of many species of **Uromyces**, except for uni- or bicellular teliospores, are identical with those of **Puccinia**, indicating that individual species of **Uromyces** are more closely related to individual species of **Puccinia** than to those of their own genus. Such pairs, most numerous in North America, are represented in the USSR, for example, by the species **Uromyces aeluropodinus** and **Puccinia aeluropodis**. Only on representatives of **Leguminosae** (**Papilionaceae**) are encountered, almost exclusively, species of **Uromyces** (49 in the USSR and 31 in North America); species of **Uromyces** predominate also on **Caryophyllaceae** (10 in the USSR and 4 in North America). In the Temperate Zone **Uromyces** is exclusively confined to species of **Euphorbia**, but all its species (15 in the USSR and 9 in North America) are microspecies derived from heteroecious species by reduction of cycles, parasitic on **Leguminosae** and **Caryophyllaceae** in the uredio- and teliospore stage, and on **Euphorbia** in the aecial stage. The absence of **Uromyces** on sympetalous hosts is conspicuous. In total there are 132 species of **Uromyces** in the USSR and 120 species in North America.

There are 459 known species of **Puccinia** in the USSR and 410 species in North America. The species of **Puccinia** are most numerous on **Compositae** (100 and 70), **Gramineae** (81 and 104), **Umbelliferae** (57 and 19), and **Cyperaceae** (37 and 36), followed by the families **Polygonaceae** (20 and 10), **Liliaceae** (19 and 17), **Rubiaceae** (18 and 6), **Ranunculaceae** and **Labiatae** (17 and 12 each), **Cruciferae** (12 and 10), and **Scrophubariaceae** (6 and 14). On representatives of the remaining host families less than 10 species are known in the USSR.

In my opinion, the flora of rust fungi is more comprehensively studied in North America than in the USSR. Most inadequately studied are the floras of Soviet Central Asia, the Far East, and the eastern Arctic regions; as regards the Alpine belt, there are hardly any data for the Caucasus. Also, attention should be focused on the high-mountain flora, for it is rich in microspecies derived from the macrocyclic ancestors disseminated in the plains.

Many of the rust fungi are parasitic on cultivated plants, first and foremost grain crops, which are severely damaged by several species of rusts which drastically lower their yield. Except for very few American species all rusts on grain crops are heteroecious.

The stem rust, **Puccinia graminis**, known also as the black rust, has received more attention than other rusts. This species parasitizes wheat, oats, rye, barley, and many other cereals. The heteroecious character of rusts was revealed by de Bary, in 1885, in connection with the stem rust. The aecia develop on many species of **Berberis**, but not on the Japanese barberry, **B. thunbergii**. On species of the genus **Mahonia**, distinguished by their dense evergreen foliage, the aecia develop only on the berries. **Puccinia graminis** comprises several specialized forms: f. sp. **secalis** Erikss. et Henn., on rye and couch grass, as well as on species of barley (**Hordeum**), **Elymus**, and **Bromus secalinus**; f. sp. **tritici** Erikss. et Henn., on wheat, slightly infecting also other cultivated and wild cereals; f. sp. **avenae** Erikss. et Henn., on oats and many wild cereals; specialized forms are known also on many wild cereals. Each specialized form comprises, in turn, a certain number of physiological races. In the USSR, wheat is most severely damaged by stem rust in the Far Eastern Territory and the Northern Caucasus. In northern Europe (Denmark, Norway) extermination of the barberry has almost eliminated the epiphytes from cereals. The same may be expected in the European USSR, but not in eastern and western Siberia where the fungi overwinter in the uredial stage and the barberry is not instrumental in the dissemination of the disease. Development of the grain rusts is weakened by dusting with flowers of sulfur. A more radical control of rusts is afforded by cultivation of varieties resistant to rust fungi.

The crown rust **Puccinia coronifera** Kleb. in its specialized form, f. sp. **avenae** Erikss., infects oats in many regions of the USSR. The aecial stage develops on the purging buckthorn, **Rhamnus cathartica**. The potential danger of other buckthorn species found in the USSR is not known. It has been proved that oats are infected with crown rust by **Rhamnus dahurica**, a Far Eastern buckthorn closely related to the purging buckthorn. The infectiousness of **Rhamnus pallasii**, widespread throughout the Caucasus, should be investigated. The older buckthorn, susceptible to infection with **Puccinia coronata** (a biological species closely related to **P. coronifera**) is not a carrier of the oat rust. Extermination of the purging buckthorn promises to be a radical means of control of the crown rust, but application of this measure is bound to meet with difficulties in view of the wide distribution of the buckthorn. Other grain crops are not infected by the crown-rust form specialized on oats. Many meadow grasses are also parasitized by specialized rust forms: f. sp. lolii (Nielsen) Erikss., on **Lolium**, f. sp. **festucae** Erikss. on **Festuca pratensis** and other species of **Festuca**, f. sp. **holci** Kleb. on **Holcus**, f. sp. **alopecuri** Erikss. on **Alopecurus**, f. sp. **agropyri** Erikss. on couch grass, f. sp. **epigaei** Erikss. on **Calamagrostis epigeios**, f. sp. **arrhenatheri** Kleb. on **Arrhenatherum**, f. sp. **bromi** Mühlethaler on **Bromus**.

The brown leaf rust of wheat, **Puccinia triticina** Erikss., is widely disseminated and infects wheat intensively. The aecia develop on species
81 of meadowrue, chiefly on **Thalictrum flavum** and **T. minus**. In the European

USSR the role of the aecial stage in the dissemination of the rust is apparently negligible, for the latter overwinters in the uredial stage. According to the studies carried out by Bryzgalov the intermediate host in eastern Siberia is **Leptopyrum** (**Isopyrum**) **fumarioides**, a weed in wheat fields; whether **Thalictrum** species are also infected there is not yet clear.

The brown leaf rust of rye, **Puccinia dispersa** Erikss. et Henn., infects only **Secale cereale** and wild species of **Secale**. The teliospores germinate immediately upon maturation, although some of the spores germinate also after hibernation. Aecia develop on species of **Anchusa** (including **Lycopsis**) and may be detected by the end of the summer and in fall. **Anchusa arvensis** (= **Lycopsis arvensis**) is a weed, mostly of potato fields, whence the disease passes into the rye fields. Extermination of the intermediate host does not afford a radical means of control in this case, for the fungus may overwinter by uredia on rye winter sowings.

The barley rust **Puccinia anomala** Rostr. (= **P. simplex** Erikss. et Henn.), is distinguished by the predominance of unicellular over bicellular teliospores. In the eastern and central parts of the European USSR barley infections are usually not severe, but in the south, for example in the Crimea, infection is very severe, owing to the intermediate host — **Ornithogalum pyrenaicum** (= **O. narbonense** auct.); the deeply buried bulbs of this plant, which are not plowed up, frequently block the sowings. The parasite is apparently able to overwinter by uredia.

The yellow or striped grain rust, **Puccinia glumarum** (Schm.) Erikss. et Henn., spreads on wheat, barley, rye, and also on several wild cereals (couch grass, **Aegilops**, etc.). It develops luxuriantly in Transcaucasia, the Crimea, and Soviet Central Asia; in the more northerly regions growth is not as abundant every year. In recent years the wheat has been severely damaged even in the Leningrad Region, where it was introduced with the cultivation of the Durabel variety which is extremely susceptible to infection with this fungus. Specialized forms are not sharply differentiated in the individual cereals, but several physiological races of the organism are known. The aecial stage has not been revealed so far. We assume that it is **Aecidium valerianellae** Biv., distributed in the Mediterranean region and found in the USSR in the Crimea and Transcaucasia (still not recorded in Soviet Central Asia), which develops diffusely on species of **Valerianella**. It apparently overwinters by uredia.

The Indian corn is parasitized by the rust **Puccinia maydis** Béreng. (**P. sorghi** Schw.), which develops aecia on the yellow-blossomed species of **Oxalis** — **O. stricta** and **O. corniculata**. Aecia have been very rarely detected in Europe and never in the USSR. The aecia are known from America and southern Africa; their external appearance is very plain. In the USSR the fungus is spread on Indian corn in the western Ukraine and the Caucasus.

Many meadow grasses are infected by rust fungi, dealt with in the second part of this book.

Flax is infected by **Melampsora lini** (Pers.) Lév. s. l., which on individual species breaks up into different forms distinguished by their biology and spore size. The form parasitic on the common flax, **Linum usitatissimum**, was isolated as a separate species — **Melampsora liniperda** Palm.[1]

[1] Melampsora lini-usitatissimi (Pers., pr. p.) comb. nov.

The fibers are particularly damaged by sori developing on the stem. Some
82 flax varieties are severely infected, while others are immune. The fungus is autoecious.

The stem and rubber-containing leaves of the Indian hemp, **Apocynum venetum**, are severely injured by the fungus **Melampsora apocyni** Tranz. The parasite is widespread throughout the USSR on wild Indian hemp and is carried over to the cultivated variety as well. Its developmental cycle is not yet known, but it can be reliably stated that it is autoecious. Cotton is infected only in tropical countries, by the rusts **Cerotelium desmium** (Berk. et Br.) Arth., and **C. gosypii** (Lagerh.) Arth. Hemp was reportedly infected once by **Aecidim cannabis** Szembel (near Astrakhan), and once by **Uredium kriegeriana** (Syd.) (in Germany).

Sunflower plants are seriously damaged by **Puccinia helianthi** Schw. The fungus is autoecious and develops all spore stages. Resistant varieties of sunflower are known. In America, where the genus **Helianthus** is represented by numerous species, specialization of the fungus involves the individual species, but all forms also infect the cultivated **Helianthus annuus** In the USSR we established that the weed **Xanthium strumarium** (cocklebur) was the rust carrier; in the Ukraine the fungus is probably carried by a weed introduced from America, **Iva xanthiifolia**, and in the region of the Sea of Azov and the Black Sea it was experimentally sown on the oleaginous plant **Guizotia abyssinica**. In America, **Coleosporium helianthi** (Schw.) Arth. is encountered on species of **Helianthus** (not on **H. annuus**). In the USSR uredia were twice found on sunflower cotyledons; while it seems most unlikely that they belong to the American species, they might somehow have developed from plants infected with the local species of **Coleosporium**, for which such host changes are known.

The safflower **Carthamus tinctorius** is attacked by three rust fungi: **Puccinia carthami** Corda, which produces uredio- and teliospores in small, scattered, pulverulent sori; **P. jaczewskii** Tropova, which forms aggregates of rather large groups of compact telia, and is only known within the USSR. This is probably not a separate species, but represents the **Puccinia verruca** Thüm. transmitted to the safflower from species of the parent genus **Centaurea**. The aecia of **Aecidium carthami** Dietr. widespread on safflower in the Saratov Region (and in Estonia) are apparently also identical with the aecia of **Puccinia centaureae-caricis** Tranz. In the Far East **Coleosporium perillae** Syd. is found on **Perilla ocymoides**.

In the USSR almost all legumes, wild and cultivated alike, are attacked by species of the genus **Uromyces**. Some of them are autoecious, such as **Uromyces fabae** (Pers.) de Bary, developing aecia, uredia, and telia, on broad beans and vetch, rarely on peas; and **Uromyces phaseoli** (Rebent.) Winter, on beans; species of **Uromyces** on clover and other species are mostly dioecious, developing aecia on **Euphorbia cypariasis**, **E. esula**, **E. virgata**, and on other spurge species in a diffuse mycelium; among these species are **Uromyces pisi** (Pers.) Schroet. on peas and certain vetchlings, **Uromyces striatus** Schroet. on alfalfa, as well as species on sainfoin (**Onobrychis**), chick-peas (**Cicer**), lentils (**Lens**), lupines (**Lupinus**), sweet clover (Melilotus), and other legumes. Licorice is infected by the autoecious species **Uromyces glycyrrhizae** Magn., devoid of aecia, but developing uredia and telia on the diffuse mycelium of spermagonia; later, following repeat infection by urediospores, individual sori appear on local mycelium.

On white clover, **Trifolium repens**, there is found in addition to the macrocyclic Uromyces **trifolii-repentis** Liro the micro type Uromyces nerviphilus
83 Hotson. In the USSR soya is not infected by rusts, whereas in southern Japan it is attacked by the species **Phakopsora sojae** (P. Henn.) Sawada.

In western Europe, southern Africa, and Australia **Uromyces betae** (Pers.) Lev. infects beet plants. In the USSR the fungus was detected in the western Ukraine, where conditions are apparently unfavorable for its development.

Puccinia cichori (DC) Bell. develops on chicory, as do aecia of **P. litoralis** Rostr. Mint is parasitized by **P. menthae** Pers. Among the fungi attacking truck crops are **P. asparagi** DC on asparagus, **P. allii**(DC) Rud.; **P. porri** (Sow.) Wint. on onion and garlic; **P. acetosae** (Schum.) Körn. on dock; **P. apii** (Desm.) on celery; **P. opizii** Bubák (aecia) on lettuce; **P. isiacae** (Thüm.) Wint. (aecia) on dill and spinach; **Uromyces scirpi** (Cast.) Burr. (aecia) on parsnip and, apparently, on carrots; **Puccinia phragmitis** (Schum.) Körn (aecia) on rhubarb, etc.

Stone-fruit trees (prunes, apricots, peaches, almonds) and wild blackthorn are parasitized by the autoecious Tranzschelia **pruni-spinosae** (Pers.) Diet.; aecia develop on species of **Anemone**, in Europe mainly on **A. ranunculoides** and on the cultivated garden variety **A. coronaria**. The fungus probably overwinters by uredia. The cherry rust, **Leucotelium cerasi** (Béreng.) Tranz., which is dioecious, has no chance of ever developing in the USSR, but in the Soviet Far East cherry trees are attacked by **Thekopsora pseudocerasi** Hirats. f., while in the European part of the USSR **T. padi** Kleb. may be transmitted to cherry treees from the bird cherry.

Pear trees are sometimes severely infected by **Gymnosporangium sabinae** (Dicks.) Wint., especially in southern regions in the habitat of the wild cypresslike juniper; we have recorded heavy infections with this fungus in the Ukraine, in an orchard in which decorative shrubs of **Juniperus sabina** had inadvertantly been planted. Extermination of the juniper — carrier of several species of **Gymnosporangium** — is the only effective way of protecting the stone-fruit trees against the diseases caused by these fungi. Quince trees are attacked by a closely related species, Gymnosporangium **confusum** Plowr. **Gymnosporangium tremelloides** Hartig (= **G. juniperinum auct.**, pr. p.) develops aecia on apple trees, while the teliospores develop on the branches and trunks of **Juniperus communis** and on other species of juniper with needle-shaped leaves. In Batumi the uredial stage of **Cerotelium fici** (Cast.) Arth. is found on fig trees. In Turkmenia, **Pileolaria terebinthi** (DC) Cast. was recorded on green-almond (**Pistacia vera**).

Berry bushes of the genus **Ribes** (currant, gooseberry) are infected by several rust fungi. The most injurious is **Cronartium ribicola** Dietr., which develops on many **Ribes** species, particularly on black currants. The five-needled pines are the intermediate hosts. The linkage first detected was between **Cronartium ribicola** and the blister rust of the North American **Pinus strobus**, frequently propagated in Europe. In America **Cronartium ribicola** was not known; it was introduced there only in about 1850 from Siberia, where its alternate host is **Pinus sibirica** (= **P. cembra sibirica**). In some puzzling cases, **Cronartium** was found on currants in enclosures, or in places where the five-needled pine was not to be found within a radius of many kilometers. It is unlikely that the fungus can pass from Scots pine; it is more likely that the aecial spores are carried over

84 great distances, or that the fungus overwinters on the currants. The damage to currants and gooseberries from the developing aecia is rarely noticed although aecia are found even in the young fruits. These aecia belong to the species **Puccinia ribesii-caricis** Kleb., comprising several biological species or forms, differentiated both by the species of **Carex** on which uredia and telia develop and by the species of **Ribes** — hosts of the aecial stage. The caeomoid aecia of some biological species of **Melampsora**, which produce uredia and telia on species of **Salix**, are less injurious and more rarely encountered than the aecia of **Puccinia ribesii-caricis**. **Puccinia ribis** DC is more often parasitic on red currants, producing only telia which develop on the upper side of the leaf and, occasionally, on the berries. The indications given in floras that the fungus is found also on gooseberries and black currants is erroneous.

Raspberry plants are often parasitized by **Phragmidium rubi-idaei** (DC) Karst. Characteristic of this species are the caeomoid, paraphysate epiphyllous aecia; later, red uredia and black telia appear on the underside of leaves. In America, cultivated raspberries and blackberries are intensively infected by **Gymnoconia peckiana** (Howe) Trott.; the mycelium of this species overwinters in the rhizome and infects all shoots. In the USSR, this species was collected from raspberries (the **Rubus** species was not accurately determined) in 1912, by Barbarin, in the Turkestan Flora nurseries at Kaufmanskaya (in Uzbekistan); it was probably imported from America. Other species of **Rubus** are not cultivated in the USSR; in the wild state they are infected by several species of **Phragmidium**, as well as **Phragmotelium**, **Gymnoconia**, and **Pucciniastrum**. On barberry are found aecia of several species of **Puccinia** parasitic on cereals.

Garden and ornamental plants are attacked less by rusts. Among the latter the most important is **Phragmidium disciflorum** (Tode) James, which infects cultivated roses. The parasite is most dangerous in the aecial stage, when the abundant, red, powdery aeciospores are scattered from the erumpent aecia in the bark of the main stalk. **Puccinia iridis** (DC) Wallr. is frequently found in gardens on iris, and **Uromyces caryophyllinus** (Schr.) Wint. on pinks; these heteroecious species develop in gardens only to the uredial stage, in which they overwinter, having lost the ability to produce teliospores. Hollyhock and several other **Malvaceae** in the southern USSR are attacked by **Puccinia malvacearum** Month., imported long ago into Europe. The rust of chrysanthemum, **Puccinia chrysanthemi** Roze, has not been encountered, to the best of my knowledge, since its appearance was reported in Russia, in 1907. **Puccinia antirrhini** D. et H., rapidly and intensively spreading in Europe, was found in the USSR not long ago (1937).

Of the forest trees only conifers are seriously injured by rusts. Of the broad-leaved trees only the birch is occasionally severely infected by **Melampsoridium betulae** (Schum.) Arth., whereas poplars (including the aspen) and **Salix** are infected by species of **Melampsora**. **Melampsoridium carpini** (Nees) Diet. is found on hornbeam, only in the Caucasus, on the shores of the Black Sea, where it occasionally spreads onto filbert. **Pucciniastrum coryli** Kom. is found on species of **Corylus** only in the Far Eastern Territory. **Melampsoridium alni** Thüm. on **Alnus futicosa** in the northern USSR and in the mountains of Siberia, **M. hiratsukanum** Ito on **Alnus hirsuta** and **A. japonica** in the Far East, and **Melampsora evonymi-capraearum** Kleb. on species of spindle tree are of minor importance. On

85 the Mongolian oak (**Quercus mongolica**) **Cronartium quercus** (Brond.) Schroet. is found only in the Amur Region, where it does less damage to the oak than to the alternate host — the pine (see below). This fungus is characteristic also of Japan, China, and western parts of North America; in western Europe (England, southwestern Switzerland, southern France) it occurs only in the uredial stage. The bird cherry, throughout its area of distribution in associations with spruce, is host to **Thekopsora padi** Kleb. Generally, rusts are not known on species of **Juglans**, **Platanus**, and **Ulmus**.

Among the USSR gymnosperms, the juniper is susceptible to all species of **Gymnosporangium** in the stage of teliospores. The fungi stimulate growth of the tissues and formation of galls at the site of infection on the branches.

Of the spruce family the pine (**Pinus**) is the most severely injured by rusts of the genera **Cronartium**, **Coleosporium**, and **Melampsora**. **Cronartium** develops its blistery aecia on the pine trunk and branches. **Pinus silvestris** is parasitized by the species **Cronartium flaccidum** Winter (= **C. asclepiadeum** Fr.), which produces uredio- and teliospores on species of **Cynanchum** (**Vincetoxicum**), **Paeonia**, **Pedicularis**, as well as on many garden plants. The aecial mycelium primarily develops in the best fibers of the pine, infects the cambial cells and, penetrating the lignin, destroys mainly the cells of the resin ducts. Following local infection of the cambium, the trunk stops growing in thickness at the infected site and the atrophied bark is shed, while excessive thickening on the opposite side imparts an eccentric shape to the trunk (as seen in cross section). Infection of the resin ducts leads to saturation of the lignin with resin which flows out of the wound and hardens outside; it is the appearance of the hardened resin that inspired the name of the disease "sulfur match." The mycelium continues to expand in the trunk upward and downward, and though more slowly, also peripherally producing every year the pustular aecia. Gradually expanding, the fungus finally causes the stag-head appearance, or even the death of the tree.

A similar pattern of development is found in other species of **Cronartium**. **Cronartium ribicola** Dietr. develops the uredio- and teliospores on currant leaves (see above), and infects in the aecial stage the white pine and the Siberian pine. **Cronartium quercus** Schroet. produces on **Pinus silvestris** aecia which usually give rise to sizable globoid swellings, on which the tortuous blistery aecia appear in the following year. In the USSR the swellings are found in the Amur Region, where both uredio- and teliospores are encountered on the Mongolian oak. In western Europe the existence of the aecial stage was experimentally established on **Pinus silvestris**, resembling aecia of **Cronartium flaccidum**, but not transmissible to **Cynanchum** (**Vincetoxicum**), though able to reinfect the pine; this fungus is known as **Peridermium pini** Kleb.

Young pine shoots are seriously injured by the caeomoid aecia of the fungus **Melampsora pinitorqua** Rostr. The elongate orange-colored cushions of the aecia emerge on the shoots from under the torn epidermis. As growth stops at the site of infection, the shoot bends downward, while its tip, in response to the negative geotropism, turns upward again. These torsions have determined the name of the fungus "**Pinitorquum**" or "pine spinner."

There are indications that the mycelium overwinters in the shoot. The uredia and telia develop on the leaves of aspen. Heteroecious species of

Coleosporium give rise to pustular aecia on pine needles (of **Pinus** species).
86 Infection occurs in the fall; spermagonia appear on the needles early in spring, and later the aecia also appear. **Coleosporium** develops teliospores on herbaceous plants of moderate height; only young pine shoots are intensively infested. **Coleosporium pinicola** (Arth.) Jacks. produces only teliospores which infect the pine needles; rarely found in the USSR.

The spruce needles are injured by aecia of species of **Chrysomyxa**. Teliospores of **Chrysomyxa** germinate in the beginning of the summer and infect the needles, on which aecia appear at the end of the summer. In some years a considerable number of needles of mature spruce trees are covered with aecia of **Chrysomyxa ledi** (Alb. et Schw.) de Bary, invading the spruce from the wild rosemary. Another species that develops on wild rosemary brush, **Chrysomyxa woroninii** Tranz., infects the spruce buds, so that when the buds open in the beginning of summer all its leaves are covered with aecia, and the shoot has the appearance of a small orange brush. A third species, **Chrysomyxa pirolae** (DC) Rostr., infects the spruce cones, on which large plate-shaped aecia develop at the end of the summer on the outer lower side of the scales. In addition to the aecia of the heteroecious species of **Chrysomyxa**, spruce is infected also by micro-species of the same genus, producing only telia. In the European USSR, **Chrysomyxa abietis** (Wallr.) Unger is found in the beginning of summer on last year's needles of **Picea excelsa**, infecting mostly young trees. Infection of young conifers proceeds in the early summer. At the end of the summer, tiny yellow stripes are detected on the infected needles, on which the telia start their development at the end of winter. In the mountains near Alma-Ata **Picea Schrenkiana** is parasitized by **Chrysomyxa weirii** Jacks., a species formerly known only in America and similar to **C. abietis**; and also the Himalayan fungus **Chrysomyxa deformans** Jacks., whose confluent telia cover all young leaves emerging from the buds, thus resembling the aecial stage of **C. woroninii**.

Aecia of **Thekopsora sparsa** (Winter) Magn., also developing on spruce, have not so far been detected in the USSR. The light sand-colored globoid aecia of **Thekopsora padi** Kleb. with a thick peridium are frequently seen on spruce cones; aecia develop in great numbers on the inner, upper side of the scales of the mature cone, bent horizontally, or even slightly downward. Infection takes place in the spring with the germination of teliospores developing on the leaves of the bird cherry; in the following spring, when the bird cherry blossoms, the aecia on the cones hanging on the tree open irregularly, pouring out the spores on the young leaves of the bird cherry. The fungus reduces the yield of spruce seed.

On young larch needles are found aecia of **Melampsoridium** species, enveloped in a peridium, while aecia devoid of a noticeable peridium produced in some species of **Melampsora** develop uredio- and teliospores on leaves of **Populus** and **Salix**.

Aecia of numerous species belonging to several genera of **Melampsoraceae** develop on fir (**Abies**). Species of the genera **Milesia** and **Uredinopsis** develop on fir needles aecia with white aeciospores. Other **Melampsoraceae** develop on fir aecia with yellow or orange spores surrounded by a white peridium. The spermagonia of **Calyptospora goeppertiana** J. Künn, which precede the aecia, are rudimentary. In species of **Pucciniastrum**

the spermagonia are normally built. In the USSR there are only aecia of **Pucciniastrum pustulatum** (Pers.) Diet. (= P. abieti-chamaenerii Kleb.).
87 These aecia develop only on needles of the current year. **Hyalopsora aspidiotus** Peck infects the needles of young conifers in the spring; spermagonia appear in the following year, and the aecia develop only a year later; thus the latter can be seen on the needles only in the third year. The aecial stage of **Melampsorella cerastii** (Mart.) Winter causes the formation of witches' broom on fir. The teliospores of this fungus develop in the spring on leaves of **Stellaria** and **Cerastium** and immediately germinate. The basidiospores infect the axis of young fir shoots. Within 2—3 months the infected branchlets begin to swell, thickening continuously during the following summer. In the year following the year of infection vertical shoots grow out of the thickened parts with their leaves not in double rows, as usual, but disposed irregularly and covered with aecia. The infected conifers are conspicuous in winter, for their densely branched vertical "brooms" stand out sharply against the dark background of fir needles. The caeomoid aecia on the fir needles belong to the fungus **Melampsora abieti-caprearum** Tub.; they have not yet been found within the USSR.

COLLECTION OF RUST FUNGI, THEIR OBSERVATION IN NATURE, AND METHODS OF EXPERIMENTAL INFECTION

Rust fungi are found everywhere, but their observation requires knowledge. Attention should be paid first to those forms that produce sori in abundance, diffusely covering the infected plants, as for example, **Puccinia suaveolens** on **Cirsium arvense**, or developing on the upper side of leaves, as the uredial stages of the majority of parasites on gramineous grasses **Puccinia ribis**, etc., or forming bright patches on the upper side of leaves as the aecial stage of many **Puccinia** species, and aecia of the genus **Phragmidium**. Careful observation involves the finding of forms that induce changes in the shape of the shoots or leaves, such as for example, the rusts on spurges (**Uromyces**, **Aecidium**), the aecia of genera **Ochropsora**, **Tranzschelia**, and **Leucotelium**, the uredia of **Trachyspora**, and the aecia of **Gymnoconia**. Many rusts do not cause any changes in the infected parts of the hosts but for occasional pale patches on the leaves. Many species are encountered only by chance, during the gathering of flowering plants.

A successful study of the rust fungi involves knowledge of the flora of higher plants at the site of collection. Without knowing the host it is difficult, and sometimes even impossible, to determine the rust fungus. Therefore I strongly recommend that mycologists wishing to engage in the study of parasitic fungi collect herbaria. Collection and drying is the same for rust fungi as for higher plants. Whether the collector is acquainted with the local flora or not, it is desirable to gather simultaneously with the infected leaves the entire specimen of the host-plant, whenever possible with the flowers and fruits, and in the absence of the

latter the entire plant, since it will be easier for an experienced florist to assist in the determination of the host from the appearance of the whole plant than from isolated leaves.

In the collection of rust fungi attention should be focused on their stage of development. The finding of uredia involves a search for aecia on older, probably dead leaves. But the complete cycle of development can be elucidated only by tracing the infection on the plant throughout its
88 growth period. It is particularly difficult to discover the alternate hosts of the heteroecious species. As soon as aecia are found in abundance it is usually easy to ascertain the host of the uredio- and teliospore stages; examination of the last year's blades of the surrounding grasses, sedge and other plants may reveal on them telia of fungi belonging to the genera **Uromyces** or **Puccinia**. If the aecia are already old, uredia might be found on the plants nearby. Proceeding from the uredio- or teliospore stage usually makes the discovery of the aecial host more difficult, for in many species of **Puccinia** and **Uromyces** the fungus may develop in these stages for a long time, overwintering by the mycelium of the uredial stage without developing aecia, because the aecial host may not even grow in the vicinity. It is also difficult to ascertain the developmental cycle of species of **Melampsoraceae**, and definitive clarification is possible only with the aid of experimental infections.

While dealing for many years with the determination of host changes in rust fungi I resorted to many methods. As stated earlier, observation in nature should be placed first. In some cases careful examination of the phytogeographical association proved helpful, since both hosts of the heteroecious species usually belong to the same association. Here are a few examples. It may be assumed that the majority of species of which only the uredio- and teliospores are known — and in particular parasites of **Monocotyledones** — are heteroecious. Therefore I assumed that **Puccinia iridis** is heteroecious, but was still far from discovering the host plant of the aecial stage. **Puccinia iridis** is frequently encountered in the gardens of the southern USSR and western Europe where it has, however, completely lost the ability to produce teliospores. In the European USSR the fungus with teliospores is rarely found in meadows and woods, but it is widespread on **Iris ruthenica** in the steppes and the adjoining regions of western Siberia and Krasnodar Territory. Studying the flora of these places made possible the discovery of the aecial host. From the works of P. N. Krylov I learned that these steppes are the habitat of **Valeriana dubia**, whereas in the European USSR species of **Valeriana** are distributed in more humid areas, in which iris species susceptible to infection by **P. iridis** are not found. Recalling that aecia collected in Siberia from **Valeriana** were frequently referred to **Uromyces valerianae**, although the uredial and telial stages of the latter were not collected there, I concluded that the aecia found on **Valeriana** were actually of **Puccinia iridis**, as was subsequently confirmed by experimental infection.

Similar considerations led me to discover the connection of the aecia on **Nitraria schoberi** with the fungus **Puccinia aeluropodis** on the grass **Aeluropus**; but in this case the areas of distribution of **Aecidium nitrariae** and **Puccinia aeluropodis** proved to be comparable. It is

sometimes helpful to compare a presumably heteroecious species with similar species for which the aecial host is already known. For example, **Puccinia pygmaea** is characterized by telia enclosed in the epidermis and, especially, by the presence of clavate paraphyses in the uredia. To the same type belongs **Puccinia arrhenatheri**, developing aecia on barberry (in the given case with the formation of "witches' broom"), as well as the American species **P. koeleriae** Arth. with aecia on **Berberis** and **Mahonia**, and **P. montanensis** with aecia on **Berberis**. **Puccinia pygmaea** also proved to be associated with **Berberis**. All or almost all species of **Puccinia** developing uredia and telia on **Cyperaceae**, and with two pores on the urediospores, develop aecia on **Compositae**. The connection of **Aecidium leucospermum** on **Anemone nemorosa** with **Ochropsora sorbi**
89 on mountain ash was successfully established by the observation that **Ochropsora** is found in profusion on young, low-growing specimens of mountain ash, whereas taller specimens are seldom infected.

The method elaborated by us for the indirect determination of the alternate host based on the comparison of aecia, uredia, and telia of the unknown heteroecious species with the teliospores of microspecies parasitic on the aecial hosts (or their closely related species) of heteroecious species was earlier described in detail (Tranzschel, 1934b). In essence the method is as follows: Assuming that a certain heteroecious species of **Aecidium** is according to the key parasitic on the same plant (or a closely related one) as the microspecies which develops only teliospores, the key should be searched for a species that develops uredia and telia and whose teliospores are similar to those of the earlier found microspecies. Conversely, proceeding from the presumptive heteroecious species with uredio- and teliospores the microspecies should be found which has teliospores; the host of this microspecies or a closely related plant will be the host of the aecial stage. For example, we were interested in the distribution of **Uromyces carici-sempervirentis** E. Fischer on a certain sedge in Switzerland; we had only the description of this fungus to guide us. Looking through the microspecies of genus **Uromyces** we found that the teliospores of **Uromyces phyteumatum** fit quite well the description of the teliospores of **U. carici-sempervirens**, and further concluded that **Aecidium phyteumatum** distributed in Switzerland would be the corresponding aecial stage. I found the same relationship between **Aecidium punctatum** on **Anemone** and **Tranzschelia pruni-spinosae** which develops uredio- and teliospores on prunes, and **Tranzschelia fusca**, which develops teliospores on **Anemone**; I concluded from this that **Aecidium punctatum** constitutes the aecial stage of **Tranzschelia pruni-spinosae**. The aecia found on **Ranunculus ficaria** were referred to **Uromyces rumicis** on account of the identity of the teliospores of **Uromyces ficariae** (microspecies) with the teliospores of **Uromyces rumicis**.

The link between the individual fungal stages should be substantiated by experimental infections. In the majority of species of **Puccinia**, **Uromyces**, **Melampsora**, etc., the teliospores cannot germinate immediately upon maturation; they acquire this ability only in the subsequent spring. The factor eliciting germination is not the low winter temperature, but the repeated wetting and drying of the teliospore. Leaves with teliospores can be collected later in the fall in bags of burlap or of

other loose tissue, which are then suspended in the open, either in a garden, slightly above ground level, or outside the window. If warmer spells and thawings alternate, the spores will soon acquire the ability to germinate, whereas if snow falls early and remains for a longer period this ability appears later. In the conditions prevailing in Leningrad it usually occurs in May. At this time the plants on which the teliospores are to be sown should be prepared. Seedlings with several leaves are most appropriate. The plants can be dug out from the vicinity but in this case they might be already infected. In order to avoid errors some of the plants should be left uninfected and kept in the same conditions as the infected ones; these plants serve as controls. The planted pots set on small stands or trays are placed on plates or basins. Then, in order to ascertain that the spores can germinate, they are transferred to a humid chamber with adequate aeration, the leaves with the teliospores are soaked for several hours and placed over the experimental plants, either on nets or pressed with the fungi downward, onto dishes with wet
90 turf, or directly onto the leaves. Then, the pots with the infected plants are covered with glass bell jars or other jars, adequately wide and high, lined with wet filter paper so that the jars rest on the tray containing some water. The plants are sprayed with water in order to keep the air under the bell jars saturated with humidity. The jars are removed after 3—4 days. If the plants wither after removal of the jars they are again covered, but with dry bell jars; the plants thus become adapted to dry air. Signs of infection can be noticed, according to the temperature of the room, within 5—12 days. After the appearance of spermagonia it is expedient to sprinkle the leaves and to transfer the spermatia by means of needles from one group of spermagonia to another in order to facilitate fertilization and normal development of aecia. Sprayers containing the spores proved very handy in experimental infection with aeciospores or urediospores. From profusely developed aecia the spores can be collected as follows: the aecia are placed with the ostiole downward on a slide, or on smooth paper, covered with a small bell, and kept in this position overnight. In the morning, a considerable number of aeciospores is discharged; the spores are scraped off and suspended in water. The aeciospores should not be extracted with needles from the aecia, for with this procedure the majority of spores will prove to be immature. Slightly dried spores germinate better than those collected wet. Infection with aeciospores proceeds in the same way as infection with teliospores.

Bibliography

Publications in Russian

Abdullaev, S. G. and S. I. Shipikova. Obzor boleznei ovoshchnobakhchevykh kul'tur osnovnykh ovoshchevodcheskikh raionov Azerbaidzhanskoi SSR (Survey of the Diseases of Vegetable and Cucurbitaceous Crops in the Main Truck-Farming Regions of the Azerbaijan SSR). Synopses of reports. — Ob"edinennaya sessiya Sektsii zashchity rastenii VASKHNIL i Otdeleniya biologicheskikh nauk AN SSSR, Vol. 1 : 74—79. Baku, 1949.

Puccinia porri Wint. is mentioned.

Abramov, I. I. Chem boleyut kul'turnye rasteniya (Diseases of Cultivated Plants). Khabarovsk-Vladivostok. 1928. 112 p.

Adrianov, A. Nikolai Mikhailovich Mart'yanov (Nikolai Mikhailovich Mart'yanov). — Trudy Botanicheskogo Sada Yur'evskogo Universiteta, Vol. 4 : 134—141. 1903.

A review of the activities of N. M. Mart'yanov in connection with the 25th anniversary of the Minusinsk Museum. According to the author, the Museum's herbaria contain 1,127 forms of microscopic fungi arranged according to the hosts they parasitize. The author also reports on the works of Thümen and Saccardo which comprise lists of fungi collected by Mart'yanov in Siberia.

Agarkov, V. A. Rzhavchina svekly i mery bor'by s nei (Beetroot Rust and its Control). — Agrobiologiya, No. 3 : 96—105. 1955.

Report on various control methods applied against rusts. According to the author, best results in the control of rusts were achieved with granozan.

Aksel'rod, D. M. — In book: "Kul'tura kauchukonosov." Moskva. 1948. 359 p.

Puccinia variabilis is mentioned on page 234.

Aleksakhin, V.N. Razvitie yarovoi rzhi v 1924 godu (Development of Rusts in Summer Crops in the Year 1924). — Izdanie Amurskoi Oblastnoi Sel'skokhozyaistvennoi Opytnoi Stantsii, No. 1 : 5—8, Blagoveshchensk. 1924a.

Rust fungi are reported.

Aleksakhin, V. N. Porazhenie rzhavchinoi (**Puccinia pruni spinosae** Pers.) sliv i bor'ba s nei (Rust Infections of Prunes (**Puccinia pruni spinosae** Pers.) and Their Control). — Izdanie Amurskoi Oblastnoi Sel'skokhozyaistvennoi Opytnoi Stantsii, No. 3 : 22 — 25, Blagoveshchensk. 1924b.

The fungi mentioned prove to be common in the Amur Region.

Alekseev, A. Materialy k mikologicheskoi flore Tatarskoi respubliki (Additions to the Mycoflora of the Tatar Republic). — Izv. Kazansk Inst. Sel'sk. Khoz. i Lesov, No. 1 : 60 — 98. 1927.

A list of fungi collected in the environs of Kazan: Coleosporium, 4 species; Melampsora, 5 species; Phragmidium, 3 species; Puccinia, 14 species, Pucciniastrum padi Diet.; Uromyces, 8 species.

Alimbekova, M. G. Bolezni kok-sagyza v Gor'kovskoi oblasti (Diseases of Kok-Saghyz in the Gor'ki Region). — Trudy Gor'kovsk. Sel'sko. Khoz. Inst., 6 (2) : 130 — 133. 1950.

Puccinia variabilis (? BK) found wherever kok-saghyz sown.

Alyavdina, K. N. Materialy k gribnoi flore Ivanovo-Voznesenskoi gub. (Data on the Mycoflora of the Ivanovo-Voznesensk Province). — Izv. Ivanovo-Voznesensk. Politekh. Inst., Vol. 12:147—164, Ivanovo-Voznesensk. 1928.

The list comprises 279 species of which 74 are rusts.

Alyavdina, K. N. Materialy po gribnoi flore lesa Ivanovskoi oblasti (Material on the Mycoflora of the Forests in the Ivanovo Region). — Rastitel'nye resursy Ivanovskoi oblasti, pp. 95 — 101. 1949.

Ten rust species reported on the forest trees and shrubs.

Andreev, N. I. Gribnye parazity Donskoi oblasti (Parasitic Fungi in the Don Region). — Severo-Kavkazskoe kraevoe zemel'noe upravlenie, Rostov-na-Donu. 1924. 27 p.

Rust fungi are reported on grains and other plants.

Angabadze, T. T. Mikoflora Kartli (Mycoflora of Kartli). — Vestnik Gosudarstvennogo Muzeya Gruzii im. Dzhanashiya, Vol. 15 — A : 159 — 182. 1951.

Seventy-two species of rust fungi are reported.

Annenkov, N. Flora mosquensis exsiccata, cent. I — XXIV, 1849 — 1951. List of the Rust Fungi. — Byulleten' Moskovskogo Obshchestva Ispytatetelei Prirody, Vol. 1 : 1 — 53. 1897.

Anpilogov, M. Z. Otdalennaya gibridizatsiya pri selektsii ovsa na ustoichivost' k gribnym zabolevaniyam (Remote Hybridization during Selection of Oats Resistant to Fungal Diseases). — Leningradskaya

Gosudarstvennaya Selektsionnaya Stantsiya. Sbornik Nauchno-Issledovatel'skikh Rabot. Zernovye i zerno-lobovye kul'tury, Vol. 1: 98–120. 1951.

"Hybridization of Avena sativa on A. byzantina proved to be exceptionally promising for the separation of resistant oat strains from the susceptible ones" (page 119) — to crown rust and loose smut.

Aref'ev, L. A. Vidy roda Puccinia Pribaltiiskogo kraya (Species of the Genus Puccinia in the Baltic Territory. — Materialy po Mikologicheskim Obsledovaniyam Rossii, No. 4, Petrograd. 1916a. (Reprint) 45 p.

The survey (key to determination) comprises 127 species; only 42 species on Cyperacea and Graminea are recorded in the lists. The site of collection and the host plants are reported; critical remarks accompany many species descriptions. The survey was discontinued.

Aref'ev, L. A. Vidy roda Uromyces Pribaltiiskogo kraya (Species of the Genus Uromyces in the Baltic Territory). — Izv. i Tr. S. — kh otd. Rizhsk. Politekh. Inst., 3(2): 117–156. 1916b.

Thirty-two species are reported according to a personal collection and data from literature. The description of many species is accompanied by critical notes.

Arkhangel'skaya, L. N. Bolezni lyutserny v Kara-Kalpakii (Diseases of Alfalfa in Kara-Kalpak). — Sots. Sel'sk. Khoz. Uzbekistana, No. 6: 30–31. 1939.

Alfalfa rusts.

Aroshidze, M. A. K izucheniyu voprosa ustoichivosti gibridov Dolis-puri k zheltoi rzhavchine (Studies on the Resistance of Dolis-puri Hybrids to Yellow Rust). — Trudy Tbilisskogo Botanicheskogo Instituta, Vol. 14: 155–172. 1952.

Artem'ev, G. V. Vrediteli i bolezni plodovykh derev'ev (Pests and Diseases of Fruit Trees). — Trudy Sochinsk. Op. St. Subtrop. i Yuzhn. Plodov. Kul'tur, Nos. 9–10: 189–226. 1935.

Tranzschelia pruni-spinosae (Pers.) Diet.

Arutyunyan, E. S. Materialy k vrednoi mikoflore lesov Zangezura (Data on Injurious Mycoflora of the Zangezur Forests). — Izv. AN Arm. SSR, 3(7): 575–583. 1950.

Reports on Melampsora populina Wint., Phragmidium subcorticium Wint., Gymnosporangium confusum Plowr., Puccinia graminis Pers. Bibl. 16 references.

Arutyunyan, E. S. Nekotorye parazitnye i saprofitnye griby lesov Samdashinskogo raiona Armyanskoi SSR. (Materialy k lesnoi mikoflore Armenii. Soobshchenie 2 – e) (Some Parasitic and Saprophytic

Fungi in the Forests of Shamshadinskii District of the Armenian SSR. (Contributions to the Forest Mycoflora of Armenia. Communication 2)). — Trudy Botanicheskogo Instituta AN Arm. SSR, Vol. 9 : 109 — 120. 1953.

Melampsora salicis caprea Winter, Gymnosporangium confusum Plowr., Phragmidium rubi (Pers.) Winter, Ph. subcorticum Winter are reported.

Arutyunyan, E. S. Vrednaya mikoflora drevesnykh porod i kustarnikov dubovykh lesov Yuzhnoi Armenii (Injurious Mycoflora of Trees and Shrubs in the Oak Forests of Southern Armenia). — Erevan, Izdatel'stvo Erevanskogo Universiteta. 1955. 104 p. Ill.

Avakyan, S. A. Obzor boleznei plodovykh kul'tur Armyanskoi SSR (Survey of the Diseases of Fruit Crops in the Armenian SSR). — Mikrobiologicheskii sbornik, I, AN SSSR, Armyanskii Filial, pp. 133 — 146. Erevan, 1943.

Gymnosporangium tremelloides Hart., G. sabinae (Dicks.) Wint., G. confusum Plowr. are mentioned.

Azbukina, Z. M. K biologii nekotorykh vidov rzhavchinnykh gribov, porazhayushchikh zlaki v Primorskom krae (The Biology of Some Species of Rust Fungi Parasitizing Grasses in the Maritime Territory). — Soobshch. Dal'nevost. Fil. AN SSSR, Vol. 2 : 19 — 21. 1952a.

The author reveals the mass wintering of rusts developing on different grains in the fall by urediospores. 3 references.

Azbukina, Z. M. Steblelist moshchnyi (Caulophyllum robustum) — promezhutochnyi khozyain rzhavchinnogo griba Puccinia poae sudetica (Caulophyllum robustum — an Intermediate Host of the Rust, Puccinia poae sudetica). — Soobshch. Dal'nevost. Fil. AN SSSR, Vol. 2 : 21 — 22. 1952b.

The connection of Aecidium caulophylli to Caulophyllum robustum with the cycle of Puccinia poae sudetica, which produces uredio — and teliospores on Millium effusum (and meadow grasses — Poa), is demonstrated by experimental infections. In the author's experiments M. effusum is readily infected by aeciospores from Caulophyllum, with the production of II and III; whereas species of Poa are not infected. The author explains this by the absence of corresponding biological forms.

Azbukina, Z. M. O porazhaemosti rzhavchinoi dikorastushchikh zlakov v Primorskom krae (Susceptibility to Rust Infections of Wild Grasses in the Maritime Territory). — Soobshch. Dal'nevost. Fil. AN SSSR, Vol. 5 : 17 — 21. 1952c.

Azbukina, Z. M. Rzhavchinnye griby, porazhayushchie zlaki v Primorskom krae (Rust Fungi of Grain in the Maritime Territory). Candidate Thesis, Vladivostok. 1952d. 27p.

Thirty-nine species of grain infecting rusts are indicated; the results obtained in numerous experimental cross infections of grain by urediospores of different species and forms of rust fungi are tabulated.

Azbukina, Z. M. Rzhavchinnye griby, novye dlya flory SSSR (Newcomers to the Rust Flora of the USSR). — Bot. mater. Otd. spor. rast. Bot. Inst. AN SSSR, Vol. 10 : 213 — 220. 1955.

Puccinia diarrhenae Miyabe et Ito, P. elymina Miura, P. miscanthi Miura, P. poae-pratensis Miura, P. rangiferina S. Ito are described in detail; the uredio- and teliospores of the species are illustrated.

Babayan, A. A. Novye dannye o gribnykh parazitnykh zabolevaniyakh kul'turnykh rastenii Armyanskoi SSR (New Data on Parasitic Fungi Pathogenic for Cultivated Plants in the Armenian SSR). — Sbornik Trudov po Zashchite Rastenii, Armyanskii Nauchno-Issledovatel'skii Institut Tekhnicheskikh Kul'tur, No. 2:102—111. 1949.

Tranzschelia pruni-spinosae on peach is reported.

Bakhtin, V. S. Materialy k mikologicheskoi flore Samarskoi gubernii. Spisok parazitnykh gribov, sobrannykh v 1913 i 1914 gg. v Buzulukskom uezde (Data on the Mycoflora of the Samara Province. List of Parasitic Fungi Collected in Buzuluk County in 1913 and 1914). — Izvestiya Samarskogo Gosudarstvennogo Universiteta, Vol. 3 : 1 — 5. 1922.

Melampsora Helioscopia (Pers) Wint., Cronartium ribicola Dietr., Coleosporium inulae (Kze.) Ed. Fisch., Uromyces — 3 species, Puccinia, 13 species.

Bakhtin, V. S. Materialy k mikologicheskoi flore Samarskoi gubernii. Spisok parazitnykh gribov, sobrannykh v Samarskom uezde (Data on the Mycoflora of Samara Province. List of Parasitic Fungi Collected in Samara County). — Izvestiya Samarskogo Sel'skokhozyaistvennogo Instituta, Vol. 1 : 147 — 148. 1923a.

The report includes 10 species of rust fungi on different wild plants.

Bakhtin, V. S. Spisok parazitnykh gribov, sobrannykh v Buzulukskom uezde Samarskoi gubernii prof. Fauset (List of Parasitic Fungi Collected by Prof. Fauset in Buzuluk County of Samara Province). — Izvestiya Samarskogo Sel'skokhozyaistvennogo Instituta, Vol. 1 : 149. 1923b.

Melampsora pinitorqua Rostr., Coleosporium petasitidis DC, Uromyces genistae-tinctoriae Winter, Puccinia — 4 species, Phragmidium — 2 species.

Bakhtin, V. S. Pamyatnaya knizhka po boleznyam l'na (Memorandum on Flax Diseases). — Gosudarstvennyi Institut Opytnoi Agronomii, pp. 3 — 11, Leningrad. 1929.

Melampsora lini usitatissimi.

Bakhtin, V. S. and A. Belova. Spisok parazitnykh gribov, sobrannykh studentkoi A. Belovoi v Chimgane Syr-Dar'inskoi obl. letom 1922 g. (List of Parasitic Fungi Collected by Student A. Belova in Chimgan, Syr-Dar'ya Region, in the summer of 1922. — Izvestiya Samarskogo Sel'skokhozyaistvennogo Instituta, Vol. 1 : 150. 1923.

Six species of rust fungi are reported.

Baranov, E. V., A. P. Golubintseva, O. P. Gol'dmaier, and F. S. Sirazitdinova. Vrediteli i bolezni sel'skokhozyaistvennykh rastenii v Novosibirskoi oblasti i bor'ba s nimi (Pests and Diseases of Agricultural Plants in the Novosibirsk Region and their Control). Novosibirsk. 1948. 144 p.

Rust fungi on grain crops, clover, alfalfa, sunflower and flax (compiled by Golubintseva and Baranov). The list of diseases is apparently based on local observations.

Baranov, K. K stat'e o sosnovoi gubke i puzyrchatoi rzhavchine (Concerning the Article on Trametes pini and blistery rust). — Listok dlya Bor'by s Bol. i Povrezhd. Kul't. i Dikorast. Polezn. Rast., No. 2 :15 — 16. 1903.

According to the author, at the forest estate "Strashunskii Bor" (Vilna Province), 16,656 pine trees were felled from a plot of 662 dessiatines (1 dessiatine =2.70 acres=1.0925 ha.) and 970 sq. sajenes (1 sajene =7 feet =2,134 m.). Among the felled trees 6294, or 37.8%, were damaged by blistery rust, and 16 trees, or 0.1%, by Trametes pini.

Barbarin, I. E. Otchet o deyatel'nosti mikologicheskogo kabineta Salgirskoi opytnoi plodovodstvennoi stantsii za 1913 — 1914 gg. (Report of the Mycological Laboratory of the Horticulture Experimental Station of Salgir for the years 1913 — 1914). Simferopol'. 1915. 14 p.

Rust fungi are mentioned.

Barmenkov, A. S. Vyyavlenie fiziologicheskikh ras buroi listovoi rzhavchiny pshenitsy (Development of Physiological Races of the Brown Leaf Rust of Wheat). — Zashchita Rastenii, Sbornik 5 : 9 — 10. 1930.

Barmenkov, A. S. Pribor dlya izucheniya reaktsii rasteniya na parazita (Device for the Study of the Reaction of Plants to Parasites). — Zashchita Rastenii, Sbornik 7 : 148 — 149. 1935.

A device for the experimental infection of grain with rust fungi is described.

Barmenkov, A. S. Otsenka porazhaemosti standartnykh i perspektivnykh sortov pshenitsy naibolee rasprostranennymi v SSSR rasami Puccinia triticina Erickss. (Estimation of the Susceptibility to Infection with Races of Puccinia triticina Erickss. of the Prevalent and Potential Strains of Wheat in the USSR). — Izd. VIZR, pp. 11 — 12. 1937a.

Barmenkov, A. S. Geograficheskoe rasprostranenie ras Puccinia triticina Erickss. f. tritici po Soyuzu SSR (Geographical Distribution of the Race Puccinia triticina Erickss. f. tritici in the USSR). — Izd. VIZR, pp. 17 — 19. 1937b.

Barmenkov, A. S. Geograficheskoe rasprostranenie fiziologicheskikh ras buroi rzhavchiny po SSSR (Geographical Distribution of Physiological Races of Brown Rust in the USSR). — In book: "Rzhavchina zernovykh kul'tur." Raboty I Vsesoyuznoi konferentsii po bor'be s rzhavchinoi zernovykh kul'tur, VASKHNIL, pp. 180—198. (1938) 1939.

Barmenkov, A. S. Vyyavlenie fiziologicheskikh ras Puccinia graminis tritici (Pers.) Erickss. (Development of Physiological Races of Puccinia graminis tritici (Pers.) Erickss.). — VASKHNIL, Vol. 10 : 20—22. 1939.

Beilin, I. G. Rzhavchina podsolnechnika v proshlom i nastoyashchem (Sunflower Rust — Past and Present). — Vestnik Opytnogo Dela Sredne-Chernozemnoi Oblasti, Voronezh, pp. 109 — 133. 1929.

Beilin, I. G. Epifitotii rzhavchin na pshenitse za poslednie gody na Severnom Kavkaze i faktory, sposobstvovavshie ikh vozniknoveniyu i razvitiyu (The Rust Epiphyt on Wheat in the Northern Caucasus in Recent Years and Factors Instrumental in their Development and Growth). — Izv. AN SSSR, Otdelenie Matematiki i Estestvennykh Nauk, Seriya Biologii, No. 5 — 6 : 995 — 1016. 1938.

Beilin, I. G. Epifitotii koronchatoi rzhavchiny i plan sortosmeny ovsa (The Crown Rust Epiphyte and the Proposed Change of Oat Strains). In book: "Rzhavchina zernovykh kul'tur." Raboty I Vsesoyuznoi konferentsii po bor'be s rzhavchinoi zernovykh kul'tur, VASKHNIL, pp. 266 — 277. (1938) 1939.

Beilin, I. G. Glavneishie bolezni osnovnykh kul'tur v Rudnom Altae i meropriyatiya po preduprezhdeniyu ikh i bor'ba s nimi (Main Diseases of Basic Crops in Rudnyi Altai and Methods of Prevention and Control). — In: Sbornik "Sel'skoe Khozyaistvo Rudnogo Altaya," pp. 219 — 236. 1940.

Rust fungi are mentioned.

Beilin, I. G. Gribnye bolezni seyantsev i sazhentsev (Obzor) (Fungal Diseases of Plants and Seedlings (Review)). — Mikrobiologiya, 18 (4) : 377 — 389. 1949a.

Melampsora pinitorqua

Beilin, I. G. Fiziologicheskie rasy parazitov, ikh teoreticheskoe i prakticheskoe znachenie (Physiological Races of Parasites, their Theoretical and Practical Value). — Trudy Instituta Fiziologii Rastenii AN SSSR, 6(2): 58—62. 1949b. (In memory of A. A. Rikhter).

The behavior of certain races of rust fungi is reported.

Belosel'skaya, Z. G. and A. V. Sil'vestrov. Vrediteli i bolezni tsvetochnykh i oranzhereinykh rastenii (Pests and Diseases of Flowers and Hothouse Plants). —Moskva-Leningrad, Sel'khozgiz. 1953. 207 p.

Puccinia asparagi DC, P. iridis Winter, P. menthae Pers., P. chrysanthemi Roze, Cronartium asclepiadeum Fr., Phragmidium subcorticium Wint.

Benua, K. A. Kratkii predvaritel'nyi obzor mikologicheskikh i fitopatologicheskikh obsledovanii Yakutskogo kraya letom 1925 goda (Brief Preliminary Review of the Mycological and Parasitological Inspection of Yakut ASSR in the Summer of 1925). — Materialy po Mikologii i Fitopatologii, Vol. 1: 92—97. 1926.

Several species of rust fungi are reported. Aecidia of Melampsoridium sp. are reported from larch needles. Particularly severe infections were observed in young trees and shoots where, according to the author, the diseased needles were 1.5—2 times as long and slightly wider than the healthy ones (p. 95).

Benua, K. A. Predvaritel'nyi otchet po fitopatologicheskomy i mikologicheskomy obsledovaniyu Yakutskogo okruga v 1926 g. (Preliminary Report on the Phytopathological and Mycological Inspection of Yakut District in 1926). — Materialy Komissii po Izucheniyu Yakutskoi ASSR, Vol. 10: 219—235. 1929.

Peridermium pini f. corticola Lév. on Pinus sylvestris L.

Bertel's, A. O. and M. V. Gafron. Glavneishie bolezni i vrediteli sel'skokhozyaistvennykh kul'tur Leningradskoi oblasti i mery bor'by s nimi (Main Diseases and Pests of Agricultural Crops in the Leningrad Region and Methods of their Control). Leningrad. 1929. 56 p.

A section entitled "Rusts of Cereals" is included.

Bobyak, Grin'ko (H. Bobijak). Prychynky do mykol'ogii skhidnoyi Halychyny. Hryby okolytsi Berezhan (Origin of Fungi in Eastern Galichina Fungi in the Environs of Berezhany). — Zbirnyk Matematychno-Pryrodopysno-Likarskoyi Sektsiyi Naukovoho Tovarystva im. Shevchenka, Vol. 11: 1—41, L'viv. 1907.

Boevskii, A. S. O rzhavchine khlebnykh zlakov v TsChO (Rusts of Cereals in the Central Chernozem Region). — Byull. Sess. VASKHNIL, No. 2: 15—17, Voronezh. 1933a.

Boevskii, A. S. Rzhavchina ovsa i mery bor'by s nei (Oat Rust and its Control). — Na Zashchitu Urozhaya, No. 12 : 12 — 15. 1933b.

Boevskii, A. S. Rasprostranenie v posevakh infektsii buroi listovoi rzhavchiny pshenitsy (Distribution and Dissemination of the Brown Leaf Rust of Wheat). — Itogi nauchno-issledovatel'skikh rabot VIZR za 1935 g., pp. 111 — 116. 1936a.

Boevskii, A. S. Izuchenie perezimovki buroi listovoi rzhavchiny pshenitsy i koronchatoi rzhavchiny ovsa (Study of Wintering of the Brown Leaf Rust of Wheat and the Crown Rust of Oats). — Itogi nauchno-issledovatel'skikh rabot VIZR za 1935 g., pp. 116 — 118. 1936b.

Bondartsev, A. S. Gribnye parazity kul'turnykh i dikorastushchikh rastenii sobrannye v okrestnostyakh g. Rigi letom 1902 g. (Fungal Parasites of Cultivated and Wild Plants Collected in the Environs of Riga in the Summer of 1902). — Izv. Imperatorskogo Sankt Peterburgskogo Botanicheskogo Sada, 3(6):117—197. 1903. (For an abstract of this article, see F. Bukhgol'ts, 1903).

The list comprises 154 species of fungi. Rust fungi Nos. 19 — 79 (pp. 188 — 193).

Bondartsev, A. S. Rastitel'nye parazity kul'turnykh i dikorastushchikh rastenii sobrannye v Kurskoi gub. letom 1901, 1903 — 1905 godov (Plant Parasites of Cultivated and Wild Plants Collected in Kursk Province in the Summer of 1901, 1903 — 1905). — Trudy Imperatorskogo Sankt Peterburgskogo Botanicheskogo Sada, 26 (1) : 1 — 52. 1906.

The author lists 319 fungal species of which 96 are rusts. (Nos. 90 — 185 on pp. 32 — 40).

Bondartsev, A. S. Gribnye bolezni rastenii i mery bor'by s nimi (Fungal Diseases of Plants and Methods of their Control). — Zhurnal "Krest'yanskoe Delo," No. 7 : 3 — 51, SPb. 1909a. (Single printing).

Bondartsev, A. S. O bolezni elovykh shishek (Aecidium strobilium Abb. et Schw.) (Disease of Spruce Cones (Aecidium strobilium Abb. et Schw.)). — Sel'skoe Khozyaistvo i Lesovodstvo, 229 (1) : 61 — 64. 1909b. 2 drawings.

Bondartsev, A. S. O rzhavchine na vskhodakh ozimoi pshenitsy i mery bor'by s nei (The Rusts on Sprouts of Fall Wheat and their Control). — Sel'skii Khozyain, Vol. 24 : 1113 — 1117, SPb. 1909c. 6 drawings.

Bondartsev, A. S. O pshenichnoi rzhavchine i ubytkakh, prichinennykh eyu v odnom iz imenii Voronezhskoi gub. (Wheat Rusts and Damage Inflicted by Them on One of the Estates in the Voronezh Province). — Sel'skii Khozyain, Vol. 25 : 119, SPb. 1910.

Bondartsev, A. S. Gribnye bolezni persika, vstrechayushchiesya na Chernomorskom poberezh'e Kavkaza (Fungal Disease of the Peach Found along the Black Sea Coast of the Caucasus). — Bolezni Rastenii, No. 5—6 : 134—135. 1911.

Puccinia pruni-spinosae is reported.

Bondartsev, A. S. Griby, sobrannye na stvolakh lesnykh porod v Bryanskom opytnom lesnichestve (Fungi Collected from the Trunks of Forest Trees in Bryansk Experimental Forests). — Trudy po Lesnomu i Opytnomu Delu v Rossii, Vol. 37 : 1 — 54. 1912a. 4 tables.

With 118 species almost entirely Polyporaceae. Caeoma piniforqua A. Br., Gymnosporangium juniperinum (L.) Fr. and Peridermium pini f. corticola Willd. are reported.

Bondartsev, A. S. Gribnye bolezni kul'turnykh rastenii i mery bor'by s nimi (Fungal Diseases of Cultivated Plants and their Control). SPb. 1912b. 399 p.

Bondartsev, A. S. Bolezni kul'turnykh rastenii i mery bor'by s nimi. Pole — ogorod — sad (Fungal Diseases of Cultivated Plants and their Control. Field, Truck Garden, Orchards). Leningrad. 1931a. 599 p.

Detailed description of some rust fungi.

Bondartsev, A. S. Gribnye bolezni rastenii (Fungal Diseases of Plants). Moskva-Leningrad, Sel'khozgiz. 1931b. 32 p.

Grain rusts are described.

Bondartsev, A. S. and L. Lebedeva. Gribnye parazity Voronezhskoi gubernii, sobrannye letom 1912 goda (Fungal Parasites in Voronezh Province Collected in the Summer of 1912). — Materialy po Mikologicheskim Obsledovaniyam Rossii, Vol. 1 : 1 — 98. 1914. 2 tables.

Bondartsev, A. S. and I. L. Serbinov. Bolezni yagodnykh kustarnikov i ogorodnykh rastenii i bor'ba s nimi (Diseases of Berry Shrubs and Truck Crops and their Control). SPb. 1913. 111 p. 100 drawings.

Rust fungi of Indian corn, onion, gooseberry, raspberry, asparagus, sunflower and some legumes are described.

Bondartseva-Monteverde, V. N. K mikologicheskoi flore Poltavskoi gub. Griby, sobrannye S. S. Ganeshinym v 1916 — 17 gg. i obrabotannye V. N. Bondartsevoi-Monteverde (The Mycological Flora of Poltava Province. Fungi Collected by S. S. Ganeshin in 1916 — 1917 and Studied by V. N. Bondartseva-Monteverde). — Materialy po Mikologicheskim Obsledovaniyam Rossii, 5(4) : 1 — 32. 1921.

The list comprises 290 species of fungi of which 91 are rusts.

Borodin, I. P. Kratkii ocherk mikologii s ukazaniem gribov, naibolee vrednykh v sel'skom khozyaistve i lesovodstve (An Outline of Mycology with a Report on the Most Injurious Fungi in Agriculture and Forestry). SPb. 1897. 230+ VIII p.

Bratus', V. N. Glavneishie bolezni drevesnykh porod Bakhchisaraiskogo leskhoza. Krymskoi oblasti (The Major Diseases of Forest Trees in the Bakhchisarai Forests of the Crimean Region). — Trudy Kievskogo Sel'skokhozyaistvennogo Instituta, Vol. 5 : 270—279. 1949.

The list includes Puccinia graminis Pers., Phragmidium rubi Wint. and Melampsora pinitorqua Rostr.

Brezhnev, I. D. Novyi vid rzhavchinnogo griba (New Species of Rust Fungi). — Bot. mater. Otd. spor. Rast. Bot. Inst. AN SSSR, 6(1-6): 80-81. 1949.

Puccinia tranzscheliana Brezhn. is described from the Forest Reserve "Les na Vorskle" (in the southwestern part of Kursk Region, Borisov District). The fungus produces aecidia and spermogonia on Tragopogon brevirostris and uredia and telia on Carex colchica.

Brezhnev, I. E. Gribnye bolezni polezashchitnykh lesnykh nasazhdenii (Fungal Diseases of Field-Protecting Forest Belts). Leningrad. 1950a. 127 p.

Brezhnev, I. E. Obzor mikoflory zapovednika "Les na Vorskle" (Survey of the Mycoflora of the Forest Reserve "Les na Vorksle"). — Trudy Leningradskogo Obshchestva Estestvoispytatelei, Otd. Botaniki, 70(3): 263-287. 1950b.

Brezhnev, I. E. Parazitnaya i saprofitnaya mikoflora drevesnykh i kustarnikovykh porod polezashchitnykh lesnykh polos (Parasitic and Saprophytic Mycroflora of Trees and Shrubs of Field-Protecting Forest Belts). — Uchenye Zapiski Leningradskogo Gosudarstvennogo Universiteta, Seriya Biologicheskykh Nauk, Vol. 25 : 70—129. 1950c.

Brezhnev, I. E. Nekotorye interesnye nakhodki gribov v Belgorodskoi oblasti (Some Interesting Findings on Fungi in the Belgorod Region). — Nauchnyi Byulleten' Lenigradskogo Gosudarstvennogo Universiteta, No. 33 : 36 - 39. 1955.

Puccinia aegopodii (Schum.) Mart. and Milesia carpatica (Wrobl.) Faull. are reported.

Bryzgalova, V. A. Vliyanie rzhavchinnogo gribka Puccinia suaveolens (Pers.) Rostr. na razvitie sornyaka Cirsium arvense (The Effect of Rust Puccinia suavolens (Pers.) Rostr. on the Development of the Weed Cirsium arvense). — Bolezni Rastenii, No. 3 - 4: 101 - 118. 1928.

It may be said that after two years of successful and repeated infections with the rust P. suavolens, no ill effects whatsoever were noted in the development of Cirsium arvense (p. 117).

Bryzgalova, V. A. Buraya rzhavchina pshenitsy v usloviyakh Irkutsko-Nizhneudinskoi zony Vostochno-Sibirskogo kraya (Brown Rust of Wheat (P. triticina) in the Conditions of the Irkutsk-Nizhneudinsk Zone, Eastern Siberian Territory). — Trudy po Zashchite Rastenii Vostochnoi Sibiri, 2(4): 99 – 175. 1935a.

Bryzgalova, V. A. Otsenka sravnitel'noi ustoichivosti sortov yarovoi pshenitsy k mokroi golovne i buroi rzhavchine dlya Prebaikal'skoi chasti Vostochno-Sibirskogo kraya (Determination of the Comparative Resistance of Strains of Summer Wheat to Tilletia tritici and Puccinia triticina in the Baikal area of the Eastern Siberian Territory). — Trudy po Zashchite Rastenii Vostochnoi Sibiri, 2(4): 175—203. 1935b.

Bryzgalova, V. A. O novom promezhutochnom khozyaine buroi rzhavchiny pshenitsy (Puccinia triticina Erikss.) (A New Intermediate Host of Puccinia triticina Erickss.). — Trudy po Zashchite Rastenii Vostochnoi Sibiri, Vol. 5: 75—87. 1937a.

The author maintains that it is possible that the rust is overwintering by the aecial mycelium on Leptopyrum fumarioides.

Bryzgalova, V. A. K voprosu o temperaturnykh usloviyakh prorastaniya spor buroi rzhavchiny pshenitsy (Puccinia triticina Erikss.) v Vostochnoi Sibiri (Temperatures of Spore Germination of Puccinia triticina Erickss. in Eastern Siberia). — Trudy po Zashchite Rastenii Vostochnoi Sibiri, Vol. 5: 89—94. 1937b.

According to the author's findings, teliospores of P. triticina germinate at temperatures ranging between 2° and 26°C, with the optimum between 15° and 22°. For the germination of aeciospores the optimum is from -5° to 8° with the minimum at +2° and the maximum over 20°.

Bryzgalova, V. A. Materialy k raionirovaniyu vidov rzhavchiny zernovykh kul'tur v Vostochnoi Sibiri. Kratkie itogi rabot VIZR za 1936 (Data for the Zoning of Species of Grain Rusts in Eastern Siberia. Summaries of the Work of VIZR for 1936). — Izd. VIZR, pp. 49 – 50. 1937c.

The distribution and pathogenicity of grain rusts in Eastern Siberia is reported.

Bryzgalova, V. A. K biologii Puccinia graminis Pers. f. secalis (On the Biology of Puccinia graminis Pers. f. secalis). — Trudy VIZR, Vol. 3: 201 – 204. 1951.

Bukhgeim, A. N. K biologii gribka Melampsora lini (Biology of the Fungus Melampsora lini). — Zhurnal Novocherkasskogo Otdeleniya Russkogo Botanicheskogo Obshchestva, pp. 38 – 40. 1919.

Data on the dimensions of urediospores of M. lini on five species of flax.

Bukhgeim, A. N. Obzor boleznei rastenii v Donskoi oblasti v 1919 g. (Review of Plant Diseases in the Don Region in 1919). — Trudy II Vserossiskogo Entomo-Fitopatologicheskogo S''ezda v Petrograde 25—30 oktyabrya 1920, pp. 160—164. 1921.

Fourteen species of rust fungi and their distribution are reported (p. 162).

Bukhgeim, A. N. K biologii Uromyces primulae Fuck. (The Biology of Uromyces primulae Fuck.). —Trudy Sektsii po Mikologii i Fitopatologii Russkogo Botanicheskogo Obshchestva, Vol. 1 and Trudy Moskovskogo Otdeleniya, pp. 37 —38. 1923.

The author succeeded in infecting Primula hirsuta All., P. latifolia L., P. pubescens Jacq. with aeciospores of Uromyces primulae Fuck. from Primula hirsuta All., but failed to infect P. auricula L. Aeciospores from P. auricula L. proved infective for P. auricula L. and P. pubescens Jacq., but not infective for P. hirsuta All. The author assumes that Uromyces primulae Fuck. is composed of two species: one, parasitic on Primula hirsuta All., the other on P. auricula L.

Bukhgeim, A. N. Sovremennoe sostoyanie voprosa o metodakh bor'by s rzhavchinoi zernovykh kul'tur. (Problems on Control Methods of Grain Rusts Today). — Zashchita Rastenii, Sbornik 12 : 11 —33. 1937.

Bukhgol'ts, F. V. Griby. Spisok gribov, naidennykh letom 1896 goda (A List of Fungi Found in the Summer of 1896). — Estestvenno-istoricheskie kollektsii E. P. Sheremetovoi v sele Mikhailovskom Moskovskoi gubernii. Moskva. 1897a. 27 p.

The list comprises 54 species of rust fungi: Uromyces — 7 species, Puccinia — 22 species, Trachyspora — 1 species, Trifragmium ulmariae Link, Phragmidium — 4 species, Gymnosporangium — 2 species, Melampsora — 8 species (including Thekopsora), Coleosporium — 3 species, Chrysomyxa pirolae Schr., Cronartium ribicola Dietr., Uredo agrimoniae Schr. and 3 species of Aecidium.

Bukhgol'ts, F. V. Gerbarii russkikh gribov (Fungi rossici exsiccati) (Herbaria of Russian Fungi (Fungi rossici exsiccati)). — Vestnik Russkoi Flory, I. Yur'ev, pp. 47 — 49 and 108 — 110. 1915.

Bukhgol'ts, F. V. Gerbarii russkikh gribov (Herbaria of Russian Fungi). Moskva. 1916. See also Izvestiya i Trudy Sel'skokhozyaistvennogo Otdeleniya Rizhskogo Politekhnicheskogo Instituta, 2 (4). 1915.

List of Nos. 51—59 and 551—600. Rust fungi Nos. 62—80 and 554—587.

Bukhgol'ts, F. V. Materialy k flore gribov ostrova Saare (Data on the Mycoflora of Saare Island). — Materialy po Mikologicheskim Obsledovaniyam Rossii, Vol. 3 : 3—35. 1916.

The list comprises 445 fungal species of which 114 are rust fungi.

Burov, S. S. Rzhavchina zernovykh khlebov v 1936 g. na yuge Kazakhstana. Kratkie itogi rabot VIZR za 1936 g. (Grain Rusts of Southern Kazakhstan during 1936. Summaries of the Work of VIZR for 1936). — Izd. VIZR, pp. 45—46. 1937.

Cheremisinov, N. A. Bolezni kauchukonosov (Diseases of Rubber Bearing Plants). — Nauchnaya konferentsiya po izucheniyu i razvitiyu proizvoditel'nykh sil Voronezhskoi oblasti. Synopses of Reports, Voronezh, pp. 124—126. 1940.
pp. 124—126. 1940.

Rusts are mentioned (p. 125)

Cheremisinov, N. A. Rzhavchina kok-sagyza (Rusts of Kok-Saghyz). — Nauchnoe Soobshchenie Voronezhskogo Gosudarstvennogo Universiteta Vol. 1 : 91—94. 1941.

The author performed experimental infections of Taraxacum kok-saghyz, T. gymnanthum and T. officinale with urediospores of **Puccinia taraxaci** Plowr. Uredia appeared on both sides of the leaves of **T. kok-saghyz** within 12 days. Other two species were not infected. The author considers that the biological form of **P. taraxaci** on kok-sakhyz differs also in certain morphological features (not indicated by the author). His observations reveal that forms of kok-saghyz with smooth-edged leaf blades are infected more severely than forms with dissected leaf blades (the latter yield more rubber). The urediospores of the rust stored in the herbarium on the dried leaves of kok-saghyz readily germinate after two months. Apart from P. taraxaci, this work supplies the diagnosis of the aecial stage of P. silvatica Schroet.

Cheremisinov, N. A. Ustoichivost' sortov i obraztsov kok-saghyza k zabolevaniyam (Resistance to Diseases of Strains and Specimens of Kok-Saghyz). — Byulleten' Obshchestva Estestvoispytatelei pri Voronezhskom Gosudarstvennom Universitete, Vol. 5 : 31—37. 1949.

Observations were carried out on the susceptibility of kok-saghyz specimens to rust infection. According to the author, tetraploid kok-saghyz and several other specimens proved to be the least resistant (also to root rot).

Cheremisinov, N. A. Bolezni kok-sagyza i mery bor'by s nimi (Diseases of Kok-Saghyz and Means of Combating Them). Kursk. 1950. 51 p.

Rusts of kok-saghyz and their control are described.

Cheremisinov, N. A. Sokhranit' estestvennye zarosli kok-sagyza (Care of Natural Overgrowths of Kok-Saghyz). — Priroda, No. 4 : 45—46. 1951a.

Puccinia taraxaci Plowr. on kok-saghyz.

Cheremisinov, N. A. Michurinskoe uchenie — osnova meropriyatii po bor'be s boleznyami kok-sagyza (Michurin's Teachings — The Basis for Control Measures against Diseases of Kok-Saghyz). — Priroda, No. 6 : 30—38. 1951b.

Data are provided on the effects of rusts on development and content of rubber in the roots of kok-saghyz and the infectivity of strains and specimens, etc.

Chernetskaya, Z. S. Materialy k izucheniyu flory gribov Severnoi Osetii (Data on Mycoflora of the North Osetian ASSR). — Trudy Nauchno-Issledovatel'skogo Biologicheskogo Instituta pri Gorskikh Ped. i Sel'skokhoz. Institutakh, pp. 3—116. 1929.

More than 120 species of rust fungi are reported.

Chernetskaya, Z. S. Bolezni kukuruzy (Diseases of Indian Corn). — Svodnyi Otchet Gorskoi Zonal'noi Kok-Sagyzskoi Kontrol'no-Opytnoi Stantsii za 1931, Ordzhonikidze, pp. 6—57. 1932.

Puccinia sorghi Schv.

Chernetskaya, Z. S. Biotipy buroi listovoi rzhavchiny na territorii Severo-Osetinskoi ASSR i ustoichivost' sortov pshenits k naibolee vredonosnomu i rasprostranennomy iz nikh (Biotypes of the Brown Leaf Rust in the North Osetian ASSR and Resistance of Wheat Strains to Those Most Injurious and Widespread Among Them). — Trudy Gorkovsk. Sel'sk. Khoz. Inst., 4(12) : 201—216. 1941.

Infection experiments were carried out.

Chesnokov, P. G. Kratkie itogi rabot po izucheniyu ustoichivosti sel'skokhozyaistvennykh rastenii k boleznyam i vreditelyam (A Brief Summary of Studies on Resistance of Agricultural Plants to Diseases and Pests). — Sbornik Trudov Pushkinskoi Laboratorii Vsesoyuznogo Instituta Rastenievodstva, Leningrad, pp. 51—61. 1949.

This is a reference on the extensive study conducted under the guidance, and with the direct participation, of the Immunological Laboratory on grain species, forms and strains in relation to resistance to rusts in different zones of the USSR (p. 58). There is no material substantiated by fact.

Chiguryaeva, A. A. Materialy po mikroskopicheskim ostatkam iskopaemykh gribov iz tretichnykh otlozhenii SSSR (Data on Microscopic Sediments of Fossile Fungi in Tertiary Deposits of the USSR). — Bot. mater. Otd. spor. rast. Bot. Inst. AN SSSR, Vol. 9: 109—144. 1953. 6 tables, ill.

Infection with Puccinia is indicated.

Chizhevskaya, Z. A. Fiziologicheskaya kharakteristika sortov l'na, immunnykh i neimmunnykh k rzhavchine (Physiological Characteristics of Flax Strains Susceptible and Immune to Rusts). — Uchenye Zapiski Leningradskogo Gosudarstvennogo Pedagogicheskogo Instituta, Fakul'tet Estestvoznanii, Vol. 2: 59—75. 1949.

According to the author, immune strains are mainly distinguished from non-immune strains by higher osmotic pressure. The author fails to present reliable correlations between other physiological parameters and resistance.

Chumakov, A. E. Opyt aviakhimicheskogo metoda bor'by so steblevoi rzhavchinoi pshenitsy v Primor'e (Experimental Control of Wheat Stem Rust by Spraying from Aircraft in the Maritime Territory). — Kratkii otchet nauchno-issledovatel'skoi raboty v oblasti zashchity urozhaya sel'skokhozyaistvennych kul'tur Primor'e za 1949 g., Dal'nevostochnaya Stantsiya VIZR. Voroshilov-Ussuriiskii, pp. 6—13. 1950.

Chumakov, A. E. Obzor glavneishikh boleznei i vreditelei sel'skokhozyaistvennykh kul'tur na Dal'nem Vostoke v 1951 g. (Review of the Main Diseases and Pests of Crops in the Far Eastern Region in 1951). — Kratkii otchet Dal'nevostochnoi STAZR za 1951g., Vladivostok, pp. 5—28. 1952a.

Rust fungi are reported.

Chumakov, A. E. Proyavlenie buroi i lineinoi rzhavchiny na nekotorykh zlakakh v usloviyakh izolyatsii ot vozdushnoi infektsii (Incidence of Leaf and Stem Rust on Some Cereals while Isolated from Potential Air-Borne Infection). — Kratkii otchet Dal'nevostochnoi STAZR, za 1951g., Vladivostok, pp. 47—59. 1952b.

Interesting data are presented which indicate the need for further research on primary infection.

Chumakov, A. E. and M. T. Matveichuk. Povyshenie toksichnosti kolloidnoi sery, primenyaemoi protiv vozbuditelei rzhavchiny pshenitsy metodom aviaopryskivaniya (Enhanced Toxicity of Colloidal Sulfur Preparations Sprayed by Aircraft against Rust Infections). — Kratkii otchet nauchno-issledovatel'skoi raboty v oblasti zashchity urozhaya sel'skokhozyaistvennykh kul'tur Primor'e za 1950 g., Vladivostok, pp. 30—34. 1951.

D e k e n b a k h , K. N. Griby Bessarabii (Fungi of Bessarabia). — Botanicheskie Zapiski izdavaemye pri Botanicheskom Sade Sankt Peterburgskogo Universiteta, Vol. 15 : 57 — 100. 1899 — 1900a.

The index lists 115 fungal species. Bibliography.

D e k e n b a k h , K. N. Bolezni kul'turnykh rastenii Bessarabskoi gubernii (Diseases of Cultivated Plants in Bessarbia Province). — Ibid., Vol. 15 : 126 — 150. 1899 — 1900b.

The article is based on material previously published by the author (1899 — 1900a).

D e k e n b a k h , K. N. Grushevaya rzhavchina Gymnosporangium sabinae (Dickson) Winter i sposoby bor'by s neyu v usloviyakh Kryma (The Pear Rust Gymposporangium sabinae (Dickson) Winter and its Control in the Crimea). — Materialy po Mikologii i Fitopatologii, 6 (1) : 68 — 91. 1927.

Studies on the development of rusts are reported; experimental infections of pears failed to give positive results. The most effective control measure proved to be a calcium-sulfate solution.

D e m i d o v a , Z. A. Rzhavchina khlebnykh zlakov i mery bor'by s neyu (Grain Rusts and their Control). Sverdlovsk. 1927. 16 p.

A popular pamphlet.

D m i t r i e v , A. M. Parazitnye griby Yaroslavskoi gubernii (Parasitic Fungi in Yaroslavl' Province). — Trudy Yaroslavskogo Estestvenno-Istoricheskogo Obshchestva, Vol. 1 : 49 — 76. 1902.

Of the 258 species of fungi listed, Nos. 38 — 121 are rust fungi.

D m i t r i e v , S. F. Materialy k flore parazitnykh gribov Syzranskogo uezda Simbirskoi gubernii (Data on the Flora of Parasitic Fungi in Syzran County, Simbirsk Province). — Trudy Botanicheskogo Muzeya Imperatorskoi Akademii Nauk, Vol. 12 : 111 — 154. 1914.

Of the 168 species of fungi presented, 104 species are rusts (Nos. 95— 198, p. 125 — 145); the plant hosts, site of collection, date and spore form are indicated. Extensive annotations accompany many of the species. The author has carried out infection experiments with spores of several rust fungi: Melampsora larici-tremulae Kleb. (III from Populus proved infective for Larix decidua and failed to infect Chelidonium majus); M. pinitorqua Rostr. (III from Populus does not infect Larix decidua and Chelidonium majus); M. magnusiana Wagn. (proved infective for Chelidonium majus); Uromyces pisi (Pers.) Schr. (aeciospores from Euphorbia virgate proved infective for Pisum sativum, and not infective for Medicago falcata and Vicia cracca); Puccinia punctata Link (I from Galium verum produced II on the same plant, failed to infect Asperula aparine); P. helianthe Schw.

(I and III from Helianthus annuus infect the same plant but fail to infect Xantium strumarium on which spermogonia were produced in one case but not aecia); P. minusensis Thüm. (I from Mulgedium tataricum produced numerous sori of II on the same plant); P. caricis (Schum.) Rebent. (III from Carex caused infection of Urtica dioica); P. thulensis Lagerh. (III from Agropyrum caninum gave rise to O and I on Troilius europaeus, did not infect Pulmonaria officinalis); P. persistens Plowr. (I from Thalictrum minus produced II on Agropyrum repens. and did not infect A. glaucum); P. alternans Arth. (spores were sown on Bromus, Agropyrum and Thalictrum); and P. of the type rubigo-vera (sown on numerous plants).

Dobrovol'skii, M.E. Nablyudeniya nad parazitnymi gribkami Podol'skoi gubernii (Study on Parasitic Fungi of Podol'sk Province). — Bolezni Rastenii, 8(4—5): 139—146. 1914.

Of the 116 species of fungi, 18 are rusts (Nos. 14—31).

Dorozhkin, N.A. Gribnye zabolevaniya kok-sagyza v BSSR (Fungal Diseases of Kok-Saghyz in the Belorussian SSSR). — Uchenye Zapiski Belorusskogo Gosudarstvennogo Universiteta, Vol. 7: 134—139. 1948.

Puccinia taraxaci is reported.

Dorozhkin, N.A. Osobennosti razvitiya i rasprostraneniya gribnykh boleznei sel'skokhozyaistvennykh kul'tur na torfyanykh pochvakh i organizatsiya mer bor'by s nimi (Characteristics in the Development and Spread of Fungal Diseases in Agricultural Crops on Peat Soils and Organization of Control Measures). — Minsk, Izd. AN BSSR, pp. 74—86. 1949.

Rust fungi on rye, wheat, barley and oats are reported from the Minsk marsh station.

Dunin, M.S. Immunogenez i ego prakticheskoe ispol'zovanie (Immunogenesis and its Practical Utilization). — Trudy Moskovskoi Sel'skokhozyaistvennoi Akademii im. K.A. Timiryazeva, Vol. 40: 1—147. 1946.

Dvoichenkova, E. K voprosu o zabolevanii drevesnykh porod (The Diseases of Forest Trees). — Sbornik Studencheskikh Nauchno-Issledovatel'skikh Rabot, Moskovskaya Sel'skokhozyaistvennaya Akademiya, No. 4: 72—76. 1953.

Gymnosporangium confusum on hawthorn.

Dvorzhetskii, P. Puzyrchataya rzhavchina sosny (Peridermium pini) v Ranerskoi dache uchebno-opytnogo lesnichestva Kazanskogo lesotekhnicheskogo instituta (Peridermium pini in the Raner Forest Estate of Experimental Forestry of the Kazan Forestry Institute). Offprint from "Izvestiya Kazanskogo Lesotekhnicheskogo Instituta," No. 2—3: 8. 1931.

D'yakonova, E. A. Chem boleyut poleznye rasteniya i kak ikh lechit' (Diseases of Field Plants and their Treatment, Parts I and II).— Izd. Imperatorskogo Sel'skokhozyaistvennogo Muzeya, 1916. 37 p.

Dyukina, N. V. Gribnye parazity, sobrannye v Penzenskoi gubernii v 1912 g. (Fungal Parasites Collected in Penza Province in 1912).— Trudy Penzenskogo Obshchestva Lyubitelei Estestvoznaniya, Vol. 1: 21—28. 1914.

Of the 67 fungal species reported, 30 are rusts.

Egorova, I. I. Otnoshenie ekotipov lyutserny k gribnym zabolevaniyam (Behavior of Alfalfa Ecotypes to Pathogenic Fungi).— Doklady VASKHNIL, Vol. 8: 37—41. 1940.

Uromyces striatus Pass. on alfalfa (**M. sativa**) in the Northern Caucasus.

Egorova, M. N. Rasy buroi rzhavchiny v Ordzhonikidzevskom i Krasnodarskom krayakh (Races of Brown Rust in the Ordzhonikidze and Krasnodar Territories).— In book: "Rzhavchina zernovykh kul'tur." Raboty I Vsesoyuznoi konferentsii po bor'be s rzhavchinoi zernovykh kul'tur, VASKHNIL, pp. 198—204. (1938) 1939.

Elenev, P. Spisok gribov, sobrannykh v Smolenskoi gubernii letom 1897 i 1899 gg. (Index of Fungi Collected in the Smolensk Province in the Summer of 1897 and 1899).— Izvestiya Moskovskogo Sel'skokhozyaistvennogo Instituta, 10(3): 507(1)—544(38). 1904.

Forty-eight species of rust fungi. Extensive annotations accompany some of the species relating to the author's observations on the development, morphology and pathogenicity of the fungi. The distribution and pathogenicity of **Melampsora lini**, as well as measures of controlling this rust, are thoroughly dealt with (p. 533—539). The author states that **Linum catharticum** "constitutes throughout the summer a steady source of the inexhaustible reserve of persistent urediospores readily transferred by the wind," and infecting the flax. According to more recent data, the rust infecting **L. catharticum** does not pass onto cultivated flax.

Elenkin, A. A. Ocherk flory Oitsovskoi doliny (Flora of Ojcow Valley).— Protokoly zasedanii otdel. biologicheskogo obshchestva estestvoispytatelei pri Varshavskom universitete, No. 2: 9—19. 1895.

The author deals with the wide distribution of rust fungi in the Ojcow valley; greenwood of the fam. Aceraceae is erroneously indicated as most severely attacked by rust fungi.

Elenkin, A. A. O gribakh (Fungi), sobrannykh v Oitsovskoi doline za letnie mesyatsy 1896 g. (Fungi Collected in the Ojcow Valley in the Summer Months of 1896).— Protokoly zasedanii otdeleniya biologicheskogo obshchestva estestvoizpytatelei pri Varshavskom universitete.

No. 3 : 9—13. 1896.

Forty-five rust fungi listed.

Elenkin, A. A. Flora Oitsovskoi doliny (Flora of Ojcow Valley).— Varshavskii Universitet, Izv., pp. 1—167. 1900—1901. 2 tables. (Offprint 1901).

Of the 266 species of fungi listed, 52 species are rusts (p. 9—12).

Elenkin, A. A. Glavneishie zaprosy po boleznyam rastenii, prisylavshiesya v Tsentral'nyu fitopatologicheskyu stantsiyu za 1905—1907 gg. (The More Important Inquiries on Plant Diseases at the Central Phytopathological Station during 1905—1907).— Bolezni Rastenii, 2 (2) : 59—72. 1908. Ibid., April—August. 1900. Ibid., 3 (4—5): 90—94. 1909. Ibid., September—December. 1909. Ibid., 4 (1—2): 16—25. 1910. Ibid., January—July. 1910. Ibid., 4 (4—5): 50—59. 1910. Ibid., 5 (1—2): 8—28. 1911. Ibid., 6 (1—2): 15—28. 1912. See also subsequent years.

Rust fungi, predominately of cultivated plants, are reported.

Elenkin, A. A. Kratkii otchet o fitopatologicheskikh issledovaniyakh v sele Mikhailovskom (Moskov. gub., Podol'skogo uezda) v techenie leta 1910 g. (A Brief Account of the Phytopathological Studies Conducted in Mikhailovskoe (Moscow Province, Podol'sk County) during the Summer of 1910).— Bolezni Rastenii, 4 (6): 137—140. 1910.

Rust fungi are reported.

Elenkin, A. A. O primenenii moei teorii podvizhnogo ravnovesiya simbiotiruyushchikh organizmov k nekotorym konkretnym sluchayam parazitizma — rzhavchiny na khlebnykh zlakakh (Application of My Theory of Dynamic Equilibrium of Symbiotic Organisms to Actual Cases of Parasitism — Rusts on Cereals).— Bolezni Rastenii, 6 (5—6): 190—199. 1912.

Elenkin, A. A. Stroenie i zhizn' gribov. Ikh rol' v khozyaistve i zhizni cheloveka (Structure and Life of Fungi. Their Role in the Economy and Life of Man). Petrograd. 1922. 86 + IX p.

Some notes on rust fungi.

Elenkin, A. A. and I. A. Ol'. O boleznyakh kul'turnykh i dikorastushchikh poleznykh rastenii, sobrannykh letom 1912 goda na Chernomorskom poberezh'e, preimushchestvenno v okrestnostyakh kurorta Gagry (Pathogens of Cultivated and Useful Wild Plants Collected in the Summer of 1912 on the Shores of the Black Sea, Mainly near the Summer Resort of Gagra).— Bolezni Rastenii, 6 (5—6): 77—112. 1912. With 10 illustrations. Ibid., 7 (1—2): 4—42. 1913. With 8 illustrations.

Of the 44 species reported, 5 are rust fungi (p. 79—80).

E r e m e e v , I. Bolezni plodovykh derev'ev i bor'ba s nimi (Fruit-Tree Diseases and their Control). SPb. 1912. 100 p. With 77 illustrations.

Gymnosporangium and Puccinia pruni-spinosae are mentioned.

E r m e e v a , A. M. Nekotorye nablyudeniya nad zarazhaemost'yu rzhavchinoi podsolnechnika i durnishnika (Some Observations on the Infectibility of Sunflower and Cocklebur). — Bolezni Rastenii, 12 (1) : 14—15. 1923.

The author reports on the production of uredio- and teliospores of Puccinia helianthi on Xanthium strumarium infected with aecio- and urediospores from sunflower.

E r e m e e v a , A. M. Ob etsidial'noi stadii Puccinia triticina Erickss. (The Aecial Stage of Puccinia triticina Erickss.). — Bolezni Rastenii, 13 (3—4) : 123—124. 1924.

E r e m e e v a , A. M. Nablyudeniya nad etsidial'noi stadiei buroi rzhavchiny pshenitsy — Puccinia triticina Erickss. (Observations on the Aecial Stage of the Brown Wheat Rust Puccinia triticina Erickss.). — Bolezni Rastenii, 15 (4) : 145—155. 1926.

The author reports experimental infections of Thalictrum with overwintered teliospores from wheat. Thalictrum minus L. and closely related species, as well as T. flavum L., were successfully infected. T. angustifolium and T. aquilegifolium proved to be resistant. Aeciospores from Thalictrum proved slightly infective for rye and unsuccessful for barley, even after repeated infection experiments with aeciospores. Rye infections with aeciospores from Thalictrum are reported also from experimental plot in the open. Bibliography contains 16 references.

E r e m e e v a , A. M. and B. P. K a r a k u l i n. Rzhavchina podsolnechnika po nablyudeniyam na Kraevoi Nizhne-Volzhskoi s.-kh. opytnoi stantsii (Sunflower Rust According to the Observations of the Agricultural Experimental Station of the Lower Volga Territory). — Bolezni Rastenii, 18 (1) : 11—28. 1929.

The developmental cycle of Puccinia helianthi and its effects on the yield are reported. Repeated infection experiments established complete resistance of the following species: Helianthus giganteus, H. divaricatus, H. strumosus, H. grosseserratus, H, Maximitiani, H. scaberrimus and H. tuberosus; infections were carried out with aecio-, uredio- and teliospores from cultivated H. annuus. The author reports successful infections of Xanthium strumarium with aecio- and urediospores of P. helianthi and their failure to infect X. strumarium var. macrocarpus, X. echinatum and X. italicum. The author mentions the occurrence in nature of X. strumarium with well-developed uredia and telia (in Saratov, on the grounds of the University).

Ermolaev, M. F. and T. T. Popova. Bolezni i vrediteli l'na (Pests and Diseases of Flax). Kalinin. 1953. 71 p.

Melampsora lini-usitatissimi.

Estifeev, P. G. Bolezni rastenii kul'turnykh i dikorastushchikh Dzhety-Suiskoi oblasti (Diseases of Cultivated and Wild Plants in the Dzhety-Sui Region). Alma-Ata. 1925. 12 p.

Estifeev, P. G. Materialy k mikoflore Turkmenistana i sopredel'nogo s nim Khorosana (Persiya). (Sistematicheskii spisok) (Data on the Mycoflora of Turkmenistan and Adjacent Iran (A Systematic Index)). — Otchet o deyatel'nosti Turkmenistanskogo OZRA za 1924/25 i 1925/26, pp. 123—155. Samarkand. 1927a.

The index comprises 77 species of rust fungi; it provides a detailed diagnosis of the form Phragmidium rosae-lacerantis Diet. on Rosa Beggeriana Schrenk. from Kopet-Dag. Bibliography contains 9 references.

Estifeev, P. G. Bolezni kul'turnoi i nekotoroi poleznoi dikorastushchei rastitel'nosti Turkestana (Diseases of Cultivated and Some Useful Wild Plants of Turkestan). — Otchet o deyatel'nosti Turkmenistanskogo OZRA za 1924/25 i 1925/26, pp. 6—12. Ashkhabad. 1927b (?). (Reprint).

Survey of diseases according to host plants. Rust fungi on grains, alfalfa, poplar, willow, pistachio, hawthorn and rose are reported.

Ezerskaya, E. I. K voprosu o boleznyakh kok-sagyza (Diseases of Kok-Saghyz). — Trudy Ukrainskogo Nauchno-Issledovatel'skogo Instituta Ovoshchevodstva, Vol. 1 : 107—114. 1949.

Report of an inspection of Kok-Saghyz diseases in the Sumy, Kharkov, Poltava and Chernigov Regions. The author indicates that rust infections (Puccinia taraxaci) are more severe in the second year of the plant's life.

Faucet, I. Spisok parezitnykh gribov, sobrannykh v Buzulukskom u. Samarskoi gubernii (Index of Parasitic Fungi Collected in Buzuluk County, Samara Province). — Izvestiya Samarskogo Sel'skokhozyaistvennogo Instituta, Vol. 1 : 149. 1923.

Nine species of rust fungi including Coleosporium petasitidis DC.

Fedchenko, O. A. and B. A. Materialy dlya flory Ufimskoi gubernii (Data on the Flora of Ufa Province). — Materialy k Poznaniyu Fauny i Flory Rossiiskoi Imperii, Otd. Botaniki, Vol. 2 : 55—428, Moskva. 1894.

Several species of rust fungi are reported.

Fedchenko, O. A. and B. A. Spisok rastenii Amurskoi oblasti, sobrannykh preimushchestvenno I. F. Kryukovym (Index of Plants of the Amur Region, Collected by I. F. Kryukov). — Botanicheskii Zhurnal, izdavaemyi Otd. Botaniki Imperatorskogo Sankt Peterburgskogo Obshchestva Estestvoispytatelei, 1 (7—8): 211—277. (1906) 1907.

On pp. 274—275 there are listed the fungi (Nos. 471—491) determined by A. A. Jaczewski; of rusts only Chrysomyxa pirolae is mentioned.

Fedorinchuk, N. S. Osobennosti razvitiya buroi rzhavchiny pshenitsy na razlichnykh ekologicheskikh stadiyakh (Developmental Characteristics of Brown Wheat Rust in Different Ecological Stages). — Kratkie itogi rabot VIZR po rzhavchine khlebnykh zlakov za 1936, pp. 33—36, Izd. VIZR. 1937.

Fedorinchuk, N. S. Virulentnost' i effektivnost' kul'tury parazita rzhavchiny Darluca filum (Biv.) Cast. (Virulence and Effectivity of Cultures of the Darluca filum (Biv.) Cast). — Mikrobiologiya, 21 (6): 711—717. 1952.

The author performed experimental infections of wheat leaves and uredia of Puccinia triticina with a spore suspension of the parasite D. filum. According to the author "the hothouse experiment proved that the fungus D. filum, grown on a nutrient media, does not lose its virulence and can impair up to 98% of the rust postules (irrespective of the developmental stage) at a late introduction in the plant and almost entirely replaces the rust in the mycelial stage if cultures for the parasite are introduced in time in the rust-infected plant (p. 717).

Fedorov, S. M. Vrediteli i bolezni drevesnykh nasazhdenii parka Zheleznovodskogo kurorta (Pests and Diseases of Trees in the Zheleznovodsk Health Resort Park). — Materialy po Izucheniyu Stavropol'skogo Kraya, Nos. 2—3: 85—101. 1950.

Phragmidium subcorticium Wint.

Fedotova, T. I. Vyyavlenie rasovogo sostava i spetsializatsii parazitov s razrabotkoi metodov opredeleniya sortoustoichivosti rastenii (Detection of Race Composition and Specialization of Parasites with the Elaboration of Methods for the Determination of Resistant Varieties of Plants). — Itogi nauchno-issledovatel'skikh rabot VIZR za 1935, pp. 484—485. 1936a.

Data on the race composition of Puccinia triticina and the role of phenol compounds in the resistance to rust fungi.

Fedotova, T. I. Opredelenie sortoustoichivosti rastenii metodom serologicheskikh reaktsii (Serological Method for Determining Resistance of Plant Variants). — Itogi nauchno-issledovatel'skikh rabot VIZR za 1935, pp. 500—501. 1936b.

About the possibility of determining the resistance of flax to Melampsora lini and other parasites with the aid of serological reactions.

Fedotova, T. I. Primenenie serologicheskogo metoda v izuchenii rzhavchiny (Serological Methods in the Study of Rusts). — In book: "Rzhavchina zernovykh kul'tur." Raboty I Vsesoyuznoi konferentsii po bor'be s rzhavchinoi zernovykh kul'tur, VASKHNIL, pp. 163—170. (1938) 1939.

Fialkovskaya, E. A. Vehetatyvna hibrydyzatsiya yaroyi pshenytsi dlya pidvyshchennya immunosti proty buroyi irzhi — Puccinia triticina Erikss. (Vegetative Hybridization of Summer Wheat for Enhanced Immunity to the Brown Rust, Puccinia triticina Erickss.). — Trudy Instituta Genetiki i Selektsii AN UkrSSR, Vol. 3 : 78—96. 1952.

The author transplanted embryos from seeds of susceptible varieties of wheat on the endosperm of resistance varieties in order to increase the resistance to rusts and smuts. The hybrids thus obtained proved significantly more resistant to the diseases than the two generations observed. Under the effect of the endosperm of the resistant variety, the seed not only showed reduced infectibility, but also changed the type of reaction of the plant to infection.

Fisher von Val'dgeim, A. Parazitnyi grib (Puccinia graminis) (The Parasitic Fungus Puccinia graminis). — Donskaya Gazeta, No. 76 (252—261). 1878.

Flerov, S. K., E. I. Ponomareva, P. I. Klyushnik, and A. I. Vorontsov. Lesozashchita (Forest Protection). Leningrad. 1948. 480 p.

Melampsora pinitorqua, Peridermium pini and other rust fungi parasitizing forest trees are reported. (P. I. Klyushnik).

Fokin, A. Bolezni i povrezhdeniya kul'turnykh rastenii v Vyatskoi gubernii 1923 g. (Disease and Impairment of Cultivated Plants in the Vyatka Province in 1923). — Zhurnal "Vyatskaya Zhizn'," No. 1 : 1—28, Vyatka. 1924. (Reprint).

The development of 23—24 species of rusts is examined. The determination of Melampsora larici-epitea Fisch. on Salix pentandra is incorrect. The finding of spermogonia of Puccinia graminis on leaves and fruits of Mahonia is of interest.

Fomin, E. E. and R. T. Ryss. Bolezni i vrediteli ovoshchnykh, bakhchevykh kul'tur i kartofelya na Ukraine v 1947 i 1948 gg. (Diseases and Pests of Vegetable, Cucurbit and Potato Crops in the Ukraine in 1947 and 1948). — Nauchnye Trudy Ukrainskogo Nauchno-Issledovatel'skogo Instituta Ovoshchevodstva, Vol. 2 : 291—301. 1950.

Uromyces pisi on peas.

Fridrikhson, G. A. Rzhavchina pshenitsy v usloviyakh oroshaemogo Zavolzh'ya (Wheat Rust in the Irrigation Conditions of the Volga Area). — Zashchita Rastenii, Collection, 12 : 35—50. 1937.

Galeev, G. S. Selektsionnaya rabota nad ovsom na Kamenno-Stepnoi opytnoi stantsii (Selection Work on Oats at the Kamennaya Step Experimental Station). — In book: "Rzhavchina zernovykh kul'tur." Raboty I Vsesoyuznoi konferentsii po bor'be s rzhavchinoi zernovykh kul'tur, VASKHNIL, pp. 160—163. (1938) 1939.

Ganeshin, S. S. Kharakternye cherty flory yugo-zapadnoi chasti Irkutskoi gub. (Characteristic Features of the Flora in the Southwestern Part of Irkutsk Province). — Protokoly zasedanii kruzhka lyubitelei estestvoznaniya, sel'skogo khozyaistva i lesovedeniya pri Novo-Aleksandriiskom Institute. Prilozhenie k protokolam, No. 66. Zapiski Novo-Aleksandrovskogo Instituta Sel'skogo Khozyaistva i Lesovodstva, 22 (3) : 15—19. SPb. 1912.

On page 19 there are listed 7 fungal species collected by Ganeshin, of which 5 are rusts.

Ganeshin, S. S. Spisok rastenii, sobrannykh v okrestnostyakh "Ostrovkov" na r. Neve (Index of Plants Collected in the Environs of "Ostrovki" [Islets] on the Neva River). — Trudy Byuro po Prikladnoi Botanike, Vol. 9 : 479—534, Petrograd. 1916. Map.

Sixty-two species of rust fungi are reported.

Ganeshin, S. S. and V. Transhel'. Spisok parazitnykh gribov, sobrannykh v Irkutskoi gubernii S. Ganeshinym i opredelennykh V. Transhelem (Index of Parasitic Fungi Collected in Irkutsk Province by S. Ganeshin and Determined by V. Transhel'). — Trudy Botanicheskogo Muzeya Imperatorskoi Akademii Nauk, Vol. 10 : 185—214. 1913.

The index comprises 132 fungal species. Rust fungi from No. 30 to No. 122; Puccinia schizonepetae Tranz. sp. nov. is described.

Garbovskii, L. Bolezni khlebnykh zlakov v Podol'skoi gub. v 1915 g. (Diseases of Grain in the Podolsk Province in 1915). — Materialy po Mikologii i Fitopatologii Rossii, 3 (1) : 7—34. 1917.

Grain rusts are reported, with 26 bibliographical references.

Gerasimov, B. A. and E. A. Osnitskaya. Vrediteli i bolezni ovoshchnykh kul'tur. (Pests and Diseases of Fruit Crops). 3rd ed. Moskva. 1955. 606 p.

Rusts of legumes, onion, beetroot and asparagus.

Geshele, E. E. Biotipicheskii sostav buroi rzhavchiny Puccinia triticina Erickss. v Odesskom raione (Puccinia triticina Erickss. in the Odessa District). — Zashchita Rastenii, Collection, 10 : 21—27. 1936.

Geshele, E. E. Itogi rabot po rzhavchinoustoichivosti pshenits, provedennye fitopatologicheskoi laboratoriei Odesskogo selektsionno-geneticheskogo instituta (Studies on Wheat Resistance to Rusts Conducted at the Phytopathological Laboratory of the Odessa Institute of Selection and Genetics). — In book: "Rzhavchina zernovykh kul'tur." Raboty I Vsesoyuznoi konferentsii po bor'be s rzhavchinoi zernovykh kul'tur, VASKHNIL, pp. 141—148. (1938) 1939.

Geshele, E. E. Osnovy fitopatologicheskoi otsenki v selektsii (Fundamentals of Phytopathological Estimation in Selection). Moskva. 1941. 120 p.

Methods of estimating the resistance to rust fungi.

Gitman, E. and L. E. Boichenko. Spravochnik po boleznyam novykh lubyanykh kul'tur (Manual of Diseases of New Bast Crops). — VASKHNIL. 1934. 98 p.

Rust fungi are mentioned.

Gizhyts'ka, Z. Hryby sho bulo zibrano protyagom oseny 1925 ta vesny i lita 1926 rokiv (Fungi Collected during the Fall of 1925 and Spring of 1926). — Visnyk Kyyivs'koho Botanichnoho Sadu, Vol. 4 : 22—33. 1926. [In Ukrainian.]

The index comprises 258 species of fungi collected in the Botanical Garden and other gardens in Kiev. Rust fungi amount to 28 species (Nos. 212—239).

Gizhyts'ka, Z. Materiyaly do mikoflory Ukrayiny (Data on Ukrainian Mycoflora). — Izvestiya Kievskogo Botanicheskogo Sada, Vol. 9 : 92—101. 1929; Vol. 10 : 4—41. 1929. [In Ukrainian.]

The index comprises 1000 species of fungi collected mainly in the environs of Kiev. The list of rust fungi includes 31 species (Nos. 417—447). Brief annotations in English accompany some of the species listed.

Gobi, Kh. Ob odnoi novoi forme rzhavchinnykh gribov, Caeoma cassandrae (On a New Form of Rust Fungi, Caeoma cassandrae). — Botanicheskie Zapiski izdavaemye pri Botanicheskom Sade Sankt Peterburgskogo Universiteta, Vol. 1 : 166—180. 1886. See also Preliminary Report in "Trudy S.-Peterburgskogo Obshchestva Estestvoispytatelei," 16(1): 38. 1886.

Author's report on the development of Caeoma on Andromeda calyculatae in the Vyborg Province.

Gobi, Kh. and V. Transhel'. O rzhavchinnykh gribakh (Uredineae) S.-Peterburgskoi gubernii i nekotorykh chastei sosednikh s neyu Estlyandii, Vyborgskoi i Novgorodskoi gubernii (On the Rust Fungi (Uredineae) of the St. Petersburg Province and Adjacent Areas in Vyborg, Estonia and Novgorod Provinces). — Materialy k Izucheniyu Mikologicheskoi Flory Rossii. Botanicheskie Zapiski izdavaemye pri Botanicheskom Sade S.-Peterburgskogo Universiteta, 3(2): 65—123. 1891.

The index comprises 127 species of rust fungi. At the end of the index all rust fungi known at the time in the Petersburg Province, Estland (N Esthonia) and Finland are tabulated.

Golovin, P. N. Bolezni yuzhnykh maslyanichnykh kul'tur (Diseases of Oleaginous Crops in the South). — Trudy Sredne-Asiatskogo Gosudarstvennogo Universiteta, Seriya 8, Botanika, Vol. 35: 1—77. 1937.

Golovin, P. N. Griby peschanykh pustyn' Srednei Azii (Fungi of the Sand Deserts of Soviet Central Asia). — Trudy Uzbekistanskogo Filiala AN SSSR, Seriya 11, Botanika, Vol. 1: 3—48. 1941.

Uredinales (on pp. 25—29) Nos. 26—63, including Aecidium arnebiae Golovin sp. nov., without diagnosis on Arnebia decumbens (Vent.) Coss. et Kral. Bibliography contains 30 references of which 21 in Russian.

Golovin, P. N. Zakonomernosti raspredeleniya mikologicheskoi flory na Pamire (Distribution Patterns of Mycoflora in Pamir). — Izvestiya Tadzhikskogo Filiala AN SSSR, No. 8: 89—108. 1944.

Golovin, P. N. Ekologicheskie tipy gribov Srednei Asii (Ecological Types of Fungi in Soviet Central Asia). — Izvestiya AN Uzbekskoi SSR, No. 5: 80—89. 1947.

Golovin, P. N. Novye vidy gribov Srednei Asii (New Fungal Types in Soviet Central Asia). — Trudy Sredne-Aziatskogo Gosudarstvennogo Universiteta, Novaya Seriya, Biologicheskie Nauki, 14(6): 3—47. 1950a.

New species of rust fungi: Puccinia hyperici, P. macrosora, P. Naumovii, P. Woldemarii, P. Kupreviczi.

Golovin, P. N. Pyatnistost' kostochkovykh porod plodovykh derev'ev i mery bor'by s neyu (Spottiness of Amygdalaceae Fruit Stands and Means of Combating It). — Trudy Sredne-Aziatskogo Gosudarstvennogo Universiteta, Novaya Seriya, Biologicheskie Nauki, 16(6): 18. 1950b.

Golovin, P. N. Retsenziya na stat'yu I. A. Mkhitaryan "Ob izmenchivosti vidov rzhavchiny khlebnykh zlakov" (Review of the Article "On the Variability of Species of Grain Rusts" written by I. A. Mkhitaryan). — Izv. AN Arm SSR, 5(12): 13—28. 1952. Botanicheskii Zhurnal, 61(1): 106—108. 1956.

Golubkov, A. Materialy k mikologicheskoi flore Khersonskoi gubernii (aprel'-sentyabr' 1915 g.) (Material on the Mycoflora of Kherson Province (April-September, 1915)). — Materialy po Mikologii i Fitopatologii Rossii, 2 (1): 16—18. 1916.

Of the 30 species of fungi listed, 3 are rust species.

Gomolyako, N. I. Primenenie plazmoliza dlya opredeleniya zhihnesposobnosti spor rzhavchiny i vliyaniya protravlivaniya (Plasmolysis in the Determination of the Viability of Rust Spores and the Effect of Disinfection). — Mikrobiologicheskii Zhurnal, 9 (1): 38, Kiev. 1947. (Abstract).

The author states: "Notwithstanding the data found in the literature it was established by our scientists that plasmolysis can be elicited in live teliospores (III) by concentrated solutions of potassium chloride or sodium chloride on well-soaked spores. The plasmolysis proves that III is not destroyed by disinfection in solutions of mercuric chloride, calcium polysulfide and copper sulfate. The teliospores lose their viability on treatment with solutions of 0.15% and higher concentrations of formalin, and also on heating at 120°C for 15 minutes" (p. 33).

Gorlenko, M. V. Nekotorye redkie ili novye dlya Tsentral'no-Chernozemnoi obl. (TsChO) vidy parazitnykh gribov (Some Rare or New Species of Rust Fungi in the Central Chernozem Region). — Botanicheskii Zhurnal SSSR, 17 (4): 383—384. 1932.

Puccinia aegopodii (Schum.) Mart.

Gorlenko, M. V. Ustoichivost' k rzhavchine gibridov ovsa Voronezhskogo selektsentra (Resistance of Oats of the Voronezh Selection Center to Rust Fungi). — Semenovodstvo, No. 5 : 83—85. 1934a.

Gorlenko, M. V. Rzhavchina khlebov i bor'ba s neyu (Grain Rusts and their Control). — Voronezh, Izd. "Kommuna" 1934b. 32 p. Ill.

Gorlenko, M. V. Prichina massovogo porazheniya ovsa koronchatoi rzhavchinoi (Puccinia coronifera Kleb.) v 1933 godu v Voronezhskoi obl. (The Cause of Mass Infection of Oats in the Voronezh Region with Crown Rust (Puccinia coronifera Kleb., in 1933)). — Botanicheskii Zhurnal SSSR, 20 (5): 475—486. 1935a.

Gorlenko, M. V. Ne oslablyat' bor'by s rzhavchinoi zlakov (The Control of Grain Rusts Should Persist). — Na Zashchitu Urozhaya, No. 1 : 22. 1935b.

Gorlenko, M. V. Otsenka sortov yarovoi pshenitsy na ustoichivost' k fuzariozu, muchinistoi rose i buroi rzhavchine (Rating of Summer Wheat Strains on Resistance to Fusarium Infections, Powdery Mildew

and Brown Rust). — Itogi nauchno-issledovatel'skikh rabot VIZR za 1935, pp. 141—143. 1936a.

G o r l e n k o , M. V. Opredelenie rasovogo sostava buroi listovoi rzhavchiny pshenitsy v Voronezhskoi oblasti (Determination of Race Composition of the Brown Leaf Rust of Wheat in the Voronezh Region). — Itogi nauchno-issledovatel'skikh rabot VIZR za 1935, pp. 488—489. 1936b.

G o r l e n k o , M. V. Rzhavchina khlebnykh zlakov v Voronezhskoi i Kurskoi oblastyakh (Rusts of Grain Crops in the Voronezh and Kursk Regions). — Trudy Voronezhskoi Stantsii Zashchity Rastenii, 1 (12): 29—51. 1936c. With 3 illustrations.

G o r l e n k o , M. V. Rzhavchina zernovykh kul'tur i otsenka meropriyatii po bor'be s neyu (Rusts of Grain Crops and Evaluation of the Methods of their Control). — Trudy VASKHNIL, 10 (7): 46—62. 1937.

G o r l e n k o , M. V. Iskorenenie promezhutochnykh khozyaev kak metod bor'by s rzhavchinoi khlebnykh zlakov (Eradication of the Intermediate Hosts as a Control Measure against Grain Rusts). — In book: "Rzhavchina zernovykh kul'tur." Raboty I Vsesoyuznoi konferentsii po bor'be s rzhavchinoi zernovykh kul'tur, VASKHNIL, pp. 247—258. (1938) 1939.

G o r l e n k o , M. V. Rzhavchina khlebnykh zlakov i mery bor'by s neyu (Rusts of Grain Crops and Control Measures against Them). 3rd ed. Moskva. 1948. 39 p. With 11 illustrations.

Popular pamphlet.

G o r l e n k o , M. V. Bolezni rastenii i vneshnyaya sreda. Ocherki biologii i ekologii parazitov rastenii (Plant Diseases and Environment. An Outline of the Biology and Ecology of Plant Parasites). — Moskovskoe Obshchestvo Ispytatelei Prirody, Sredi Prirody, Vol. 27: 5—119. 1950.

Notes on the biology of rust fungi on cereals.

G o r y a c h e v a , E. P. Ekologicheskie osobennosti fiziologicheskikh ras Puccinia triticina Erickss. razlichnogo geograficheskogo proiskhozhdeniya (Ecological Characteristics of Physiological Races of Puccinia triticina Erickss. of Different Geographical Origin). — Kratkie itogi raboty VIZR po rzhavchine khlebnykh zlakov za 1936g. Izd. VIZR, pp. 21—25. 1937.

No significant differences between the individual races of Puccinia triticina were detected by the author in relation to the ecological conditions in the original regions or habitats.

Goryacheva, E. P. Ekologicheskie osobennosti fiziologicheskikh ras Puccinia triticina Erickss. razlichnogo geograficheskogo proiskhozhdeniya (Ecological Characteristics of Physiological Races of Puccinia triticina Erickss. of Different Geographical Origin). Candidate Thesis, Moskva. 1949. 8 p.

Goryaninov, P. Griby, pleseni i pyleviki v mediko-politseiskom i drugikh otnosheniyakh (Fungi, Moulds and Dust Grains from the Medico-Legal and Other Aspects).— From the journal "Zapiski po Chasti Vrachebnykh Nauk," SPb., No. 1 : 1—126. 1848.

Grachev, I. Spisok golovnevykh, rzhavchinnykh i muchnisto-rosovykh gribov, sobrannykh gl. obr. v okrestnostyakh Petrovsko-Razumovskogo (Index of the Fungi of Blight Rust and Powdery Mildew Collected Mainly in the Environs of Petrovskoe-Razumovskoe).— Izvestiya Petrovskoi Sel'skokhozyaistvennoi Akademii, Vol. 24 : 20. 1891. (Preprint).

The index is compiled according to the determinant type with detailed descriptions of the genera and brief characterizations of the species; it comprises 52 species of rust fungi. The index is based chiefly on the herbarium of S. G. Navashin.

Grechushnikov, A. I. Toksiny rzhavchiny (Puccinia) (Toxins of Rusts (Puccinia)).— DAN SSSR, 2 (8): 329—334. 1936.

Grodzins'ka, V. P. Materiyaly do grybnoyi flory Bilotserkivshchyny (Contributions to the Mycoflora of Belaya Tserkov').— Iz robit katedry s-h. botaniki. Zap. Bilotserkiv'sk. s.-hospodarsk. politekhn, 1(1): 193—200. 1929. [In Ukrainian.]

Fifty-two species of rust fungi are reported.

Grodzinskii, M. I. Opyt bor'by s buroi rzhavchinoi pshenitsy (Experimental Control of the Brown Rust of Wheat).— In book: "Belotserkovskii sel'skokhozyaistvennyi institut, VIII nauchnaya konferentsiya, 18—20 March 1954." Synopses of Reports, pp. 46—48, Kiev. 1955.

Grushevoi, S. E. K voprosu ob usloviyakh razvitiya i vredonosnosti koronchatoi rzhavchiny ovsa — Puccinia coronifera Kleb. (The Conditions of Development and Pathogenicity of Oat Crown Rust — Puccinia coronifera Kleb.).— Sbornik Sortovogo-semennogo upravleniya Sakharotresta, pp. 45—46, Kiev. 1930.

Grushevoi, S. E. Rzhavchina zernovykh khlebov i mery bor'by s neyu (Grain Rusts and Means of their Control).— Na Zashchitu Urozhaya, No. 10 : 14—16. 1933a.

Grushevoi, S. E. Rzhavchina zernovykh khlebov. Problema likvidatsii i nashi ocherednye zadachi (Grain Rusts. Their Eradication and Our Immediate Problems).— Sbornik VIZR, No. 6 : 51—54. 1933b.

Grusheyoi, S. E. Vesennyaya bor'ba s rzhavchinoi zernovykh khlebov (Control of Grain Rusts in the Spring). — Sbornik VIZR, No. 8 : 29—32. 1934.

Grushevoi, S. E. Rzhavchina khlebov (Grain Rusts). — Kolkhoznoe Opytnichestvo, 1(2): 9. Moskva, 1935. With 2 maps, 1 colored plate.

Grushevoi, S. E. and G. F. Maklakova. Rzhavchina zernovykh kul'tur i mery bor'by s neyu (Grain Rusts and Means of their Control). Moskva-Leningrad. 1934. 40 p. With 14 illustrations.

Grushevoi, S. E., P. Proida, and S. Tupinevich. Bolezni pshenitsy na severe (Wheat Diseases in the North). — Sbornik VIZR, No. 7 : 1—38. 1933.

Studies of the development of rust fungi on wheat and other cereals.

Grushvitskii, I. V. Bolezni zhen'-shenya (Literaturnyi obzor) (Diseases of Ginseng). — In book: "Materialy po izucheniyu zhen-shenya i limonnika," 2 : 34—70, Moskva-Leningrad, Izd. AN SSSR. 1955.

Gulkanyan, V. O. O rzhavchinoimmunnosti nekotorykh sortov mestnykh pshenits Armenii (The Immunity to Rusts in Armenia of Certain Local Wheat Strains). — NKZ Armenii, Nauchno-Issledovatel'skaya Stantsiya Zashchity Rastenii, Nauchaya Seriya, No. 4 : 1—40. 1936.

Resistance to **Puccinia glumarum** Erikss. et Henn., **P. triticina** Erikss., **P. graminis** Pers.

Gulkanyan, V. O. Priznak rzhavchinoporazhaemosti dikikh pshenits Armenii (Susceptibility Index of Wild Wheat to Rust Infections in Armenia). — Trudy Arm. AN, Seriya Biologii, Vol. 2 : 137—141. 1937.

Wild wheat strains are not distinguished by resistance to rusts. The author suggests certain changes in the systematics of wheat based upon their susceptibility to rusts.

Gulkanyan, V. O. Nasledovanie rzhavchinoustoichivosti pshenitsy Timopheevi (Inheritance of Rust Resistance in the Tymopheevi). — Izv. AN Arm. SSR, No. 7 : 51. 1947.

Gulkanyan, V. O. and S. G. Oganesyan. Rzhavchinoporazhaemost' pshenits pri ikh vnutrisortovom skreshchivanii (Rust Infectibility of Wheat during Intravarietal Crossing). — Izvestiya Armyanskogo Filiala AN SSSR, No. 3—4 (17—18): 79—90. 1942.

Gulyaev, V. V. Bolezni seyantsev sosny v lesnykh pitomnikakh Tatarskoi ASSR (Diseases of Pine Seedlings in Forestry Nurseries of the Tatar ASSR). Kazan. 1948a. 26 p.

On the spread of the pine-bud moth in nurseries. Bibliography includes 25 references.

Gulyaev, V. V. Usloviya, blagopriyatstvuyushchie poyavleniyu gribnykh zabolevanii v pitomnikakh sosny (Conditions Conducive to the Occurrence of Fungal Diseases in Pine Nurseries). — Trudy po Lesnomu Delu, Tatarskii respublikanskii otdel VNITOLES i Tatarskaya lesnaya opytnaya stantsiya VNIIKH, Vol. 9 : 3—10. 1948b.

Melampsora pinitorqua is reported.

Gulyaev, V. V. Mery bor'by s boleznyami seyantsev sosny (Means of Combating Diseases of Pine Seedlings). — Les i Step', No. 5 : 76—82. 1949.

Melampsora pinitorqua is reported.

Gulyaev, V. V. K vidovomu sostavu gribnykh boleznei zashchitnykh lesonasazhdenii Tatarskoi ASSR (Species Composition of Fungal Pathogens in Protective Forest Belts of the Tatar ASSR). — Trudy po Lesnomu Khozyaistvu, Vol. 11 : 95—128, Kazan'. 1954a.

Melampsorium betulae Arth., M. pinitorqua Rostr., Uromyces cytisi (Strauss) Schroet.

Gulyaev, V. V. Vazhneishie gribnye bolezni seyantsev listvennykh porod v Tatarskoi ASSR i mery bor'by s nimi (The Most Important Fungal Pathogens of Greenwood Seedlings in the Tatar ASSR and Measures of their Control). — Trudy po Lesnomu Khozyaistvu, Vol. 11 : 129—144, Kazan'. 1954b.

Melampsorium betulae Arch., Uromyces cytisi (Strauss) Schroet.

Gutner, L. S. and M. K. Khokhryakov. Materialy po boleznyam kul'turnykh rastenii Kol'skogo poluostrova (Data on Diseases of Cultivated Plants in the Kola Peninsula). — Vestnik Zashchity Rastenii, No. 1—2 : 245—250. 1940.

Several species of rust fungi on cultivated and wild plants.

Gutsevich, S. A. Spisok rastenii Kryma, porazhaemykh rzhavchinnymi gribami, s ukazaniem vida griba i stadii ego, kotorye vstrechayutsya na dannom vide rasteniya (Index of Crimean Plants Infected by Rust Fungi, with an Indication of the Fungal Species and Stage that Occur in the Given Plant Species). — Trudy Gosudarstvennogo Nikitskogo Botanicheskogo Sada, Vol. 24 : 89—110. 1949.

The index lists approximately 370 species of higher plants on which rust fungi were detected.

Gutsevich, S. A. Obzor rzhavchinnykh gribov Kryma (Survey of Crimean Rust Fungi). — Leningrad, Izdatel'stvo Leningradskogo Gosudarstvennogo Universiteta. 1952. 172 p.

The author describes 229 (228) species of rusts on 369 (270) species of plant hosts; the new species Uromyces brominus Gucewicz on Bromus benekeni (Lge.) Tr. and B. riparius Rehm. The text is accompanied by 140 original illustrations of rust spores.

Gvritishvili, I. D. K fitopatologicheskoi otsenke khozyaistvennykh i perspektivnykh sortov pshenits k rzhavchinam khlebnykh zlakov (Phytopathological Rating of Economic and Long-Term Strains of Wheat by Grain Rusts). — Trudy Instituta Zashchity Rastenii AN Gruz. SSR, Vol. 6 : 83—84. 1949. (Russian abstract).

Gvritishvili, S. P. K issledovaniyu vredonosnosti buroi listovoi rzhavchiny na sorte dolispuri (Studies on the Damage Caused by the Brown Leaf Rust to Wheat Variety Dolispuri). — Trudy Instituta Zashchity Rastenii, AN Gruz. SSR, Vol. 7 : 23—33. 1950.

Gvritishvili, S. P. Nablyudeniya nad rzhavchinnymi boleznyami khlebnykh zlakov v vostochnoi Gruzii (Examination of Rust Diseases of Grains in the Eastern Part of the Georgian SSR). — Trudy Instituta Zashchity Rastenii, AN Gruz. SSR, Vol. 8 : 3—18. 1952. (Russian abstract).

Illichevs'kii, S. Fitopatologichni zbore v URSR (Phytopathological Collections in the Ukrainian SSR). — Zbirn. Pam. Akad. O. V. Fomina, pp. 149—157, Vid. AN URSR. 1938.

The catalogue lists 84 species of rust fungi collected in the Poltava Region, Askanya-Nova and in the Dniepropetrovsk Region on the sandy stretches of the lower Dnieper and on the islands and along the northwestern shores of the Black Sea. The fungi were collected by Illichevs'kii and determined by Transhel'.

Instruktsiya po bor'be so rzhavchinoi zernovykh kul'tur (Instructions for the Control of Grain Rusts). — Izd. AN SSSR, Moskva. 1935. 7 p.

Isachenko, B. O. O parazitnykh gribakh Khersonskoi gubernii (The Parasitic Fungi of Kherson Province). — Botanicheskie Zapiski izdavaemye pri Botanicheskom Sade Imperatorskoga SPb. Universiteta, 5 (12): 219—240. 1896. See also, Materialy k Izucheniyu Mikologicheskoi Flory Rossii, Vol. 4 : 219—244. 1896.

Of the 116 species listed, 69 are rusts.

Isaeva, E. V. Gribnye bolezni drevesnykh i kustarnikovykh lesnykh porod Srednego Pridneprov'ya (Fungal Diseases of Forest Trees and Shrubs in the Central Dnieper Region). — Botanicheskii Zhurnal, AN UkrSSR, 9 (2): 36—43. 1952a.

Melampsora tremulae Tul., Chrysomyxa abietis (Walir.) Unger., Coleosporium sp., Phragmidium tuberculatum Mull., Ph. disciflorum (Tode) James, Puccinia coronata Corda (I) are reported. Bibliography with 9 references.

Isaeva, E. V. Mikoflora Srednego Pridneprov'ya i ee znachenie v narodnom khozyaistve (Mycoflora of the Central Dnieper Region and its Importance in the National Economy). Candidate Thesis, Kiev. 1952b. 11 p.

There are 177 species of rust fungi reported.

Ismailov, Kh. A. Mikroelementy v povyshenii ustoichivosti pshenitsy k zheltoi rzhavchine (Microelements in Wheat with Increased Resistance to Yellow Rust). — DAN, Azerbaidzhanskoi SSR, 10(7): 491—494. 1954a.

Introduction of bore, manganese, cooper and zinc in the soil reduces the susceptibility of wheat to infection with yellow rust. Positive results were obtained by spraying the wheat with solutions of bore and manganese.

Ismailov, Kh. A. Vliyanie srokov poseva na porazhaemost' pshenitsy zheltoi rzhavchinoi (Effect of Sowing Dates on the Infectibility of Wheat with Yellow Rust). — DAN Azerbaidzhanskoi SSR, 10(12): 871—873. 1954b.

Ismailov, Kh. A. Opyty po primeneniyu vnekornevoi podkormki v bor'be s zheltoi rzhavchinoi pshenitsy (Experiments on Leaf-Feeding in the Control of Yellow Rust of Wheat). — Trudy Instituta Zemled. AN Uzbekistanskoi SSR, Vol. 3: 77—82. 1955a.

Ismailov, Kh. A. Vnekornevaya podkormka povyshaet ustoichivost' pshenitsy k porazheniyu rzhavchinoi (Leaf-Feeding Enhances Resistance of Wheat to Yellow Rust). — In book: "Vnekornevaya podkormka sel'skokhozyaistvennykh rastenii," Moskva, Sel'khozgiz, pp. 268—270. 1955b.

Ivanitskaya, A. I. Griby, sobrannye v Tomskom okruge v 1910 gody i na Altae v 1911—1912 gg. (Fungi Collected in the Tomsk District in 1910 and in Altai in 1911—1912).

Of the 354 species of fungi reported, the majority are rusts, collected by A. I. Ivanitskaya and determined by V. G. Transhel' (according to N. N. Lavrov, 1938, p. 31).

Ivanov, K. S. Parazitnye griby, sobrannye v S.-Peterb. gub. letom 1898g. (Parasitic Fungi Collected in the St. Petersburg Province in the Summer of 1898). — Trudy SPb. Obshchestva Estestvoispytatelei, Sektsiya Botaniki, 30(3): 1—20. 1900.

Of the 153 fungal species, 46 are rusts.

Ivanov, V.I. Koronchataya rzhavchina ovsa i kak s nei borot'sya (Crown Rust of Oat and Control Measures). Ufa. 1948. 46 p.

Popular pamphlet.

Ivanovskii, V.A. "Chistoe boloto" v okr. g. Tobol'ska ("Clean Marsh" in the Environs of Tobol'sk). — Tobol'sk. Gub. Muzeya 18 (20) : 1—40, Tobol'sk. 1912.

Coleosporium ligulariae Thüm. is reported; the fungus was collected by the author and determined by V.G. Transhel' (according to Lavrov, 1938).

Ivanovskii, V.A. Spisok gribov iz okrestnostei Tobol'ska (Index of Species from the Environs of Tobol'sk). Manuscript (1912—1913).

The collection was undertaken near Tobol'sk in 1912. The index comprises 76 species of rust fungi, almost all determined by Transhel'. At the end of the manuscript there is an alphabetical list of the host plants.

Kalymbetov, B. Mikoflora yuzhnoi zony Gl. Turkmenskogo kanala i yugo-zap. Turkmenii i opyt prognoza razvitiya boleznei kul'turnykh rastenii pri obvodnenii i oroshenii (Mycoflora of the Southern Zone of the Main Turkmenian Canal and Southwestern Turkmenia, and a Tentative Forecast of the Development of Diseases among Cultivated Plants in Response to Flooding and Sprinkling). Candidate Thesis, Leningrad. 1953. 24 p.

Uredinales on pp. 13—16.

Kanchaveli, L.A. Materialy k mikoflore lesnykh porod Kirovakanskogo i Delizhanskogo raionov v Armyanskoi SSR (Data on the Mycoflora of Forest Trees in the Kirovakan and Delizhan Districts of the Armenian SSR). — Trudy Kirovakanskoi Lesnoi Opytnoi Stantsii, Vol. 2 : 86—96. 1942a.

Melampsora pinitorqua Rostr. on aspen leaves and pine shoots.

Kanchaveli, L. Bolezni sel'skokhozyaistvennykh rastenii i bor'ba s nimi (Diseases of Agricultural Plants and their Control), Part 1. 1942b. 356 p., Part 2. 1945. 353 p.

Rust fungi on agricultural plants are reported from the Georgian SSR.

Karaerov, P.G. Planovaya chastaya smena sortov v proizvodstvennykh posevakh i bor'ba so rzhavchinoi (Planned Changes of Varieties in Industrial Sowings for the Control of Rusts). — Selektsiya i Semenovodstvo, No. 12 : 16—21. 1952.

The author suggests sowing crops of new promising specimens in the variety without testing them at selection centers. Sowing of "young" new varieties, resistant to disease and endowed with "fresh" heredity, will raise the yield levels.

Karakulin, B. P. K voprosu o vliyanii gribnykh parazitov na urozhai klevera (Soobshchenie o nablyudeniyakh v Orlovskoi gub.) (The Effect of Fungal Parasites on the Yield of Clover. Observations in Orel Province). — Bolezni Rastenii, 10(1):1—13. 1921.

Uromyces trifolii Lév., according to the author, "leads to deterioration of hay and probably has an adverse effect on the development of seeds" (p. 12).

Karakulin, B. P. Ob opytakh po izucheniyu vredonosnosti boleznei rastenii putem primeneniya iskusstvennogo zarazheniya (Experimental Infections in the Study of the Harmfulness of Plant Diseases). — Bolezni Rastenii, 19(1—2):1—7. 1930. (Preprint).

The effects of Puccinia triticina on wheat were studied by means of experimental infections of plants transplanted onto beds. The experiments were aimed chiefly at clarifying the working methods and reliability of the results obtained.

Karakulin, B. P. and A. Lobik. K mikologicheskoi flore Ufimskoi gub. (Mycoflora of UFA Province). — Materialy po mikologicheskim obsledovaniyam Rossii, Vol. 2:1—86. 1915. With 12 illustrations.

Of the 355 fungal species listed, 73 are rusts. The aecial stage of Puccinia triticina Tranz. on Dracocephalum thymiflorum L. and Salvia pratensis L. are reported.

Karaseva, E. F. Otsenka vnekornevogo pitaniya kak priema povysheniya ustoichivosti u sortov ozimoi pshenitsy k buroi rzhavchine (Estimation of Leaf Feeding as a Means of Enhancing Resistance of Winter-Wheat Varieties to Brown Rusts). Candidate Thesis, Leningrad. 1955a. 18 p.

Karaseva, E. F. Primenenie vnekornevoi podkormki v bor'be s rzhavchinoi pshenitsy (Leaf Feeding in the Control of Rusts). — In book: "Vnekornevaya podkormka sel'skokhozyaistvennykh rastenii," pp. 264—267, Moskva, Sel'khozgiz. 1955b.

Kargopolova, N. N. Fenol'nye soedineniya pshenits v svyazi s ustoichivost'yu ikh k Puccinia triticina (Phenol Compounds of Wheat in Connection with the Resistance to Puccinia Triticina). — Itogi nauchno-issledovatel'skikh rabot VIZR za 1935 g., pp. 491—492. 1936.

Kargopolova, N. N. Khimicheskie osobennosti razlichnykh vidov pshenitsy v svyazi s ikh ustoichivost'yu k Puccinia triticina Erickss. (Chemical Characteristics of Different Wheat Species in Relation to their Resistance to Puccinia triticina Erickss.). — Trudy po Prikladnoi Botanike i Selektsii, Seriya II, Vol. 11:179—199. 1937.

Karimov, M. Otsenka sortov lyutserny na porazhaemost' gribnymi boleznyami (Estimation of Alfalfa Varieties by their Susceptibility to Fungal Infections). — Sovetskii Khlopok, Nos. 11—12:20—25. 1940.

Distribution of Uromyces striatus Schroet.

Karimov, M.A. Glavneishie gribnye parazity lyutserny v Uzbekistane i meropriyatiya po bor'be s nimi (The Main Fungal Parasites of Alfalfa in Uzbekistan and Measures to Control Them). Candidate Thesis, Leningrad. 1953. 38 p.

Karsten, P.A. Zabaikal'skie griby, sobrannye P.S. Mikhno okolo Chity v 1908 i 1909 gg. (Fungi Collected in Transbaikal by P.S. Mikhno near Chita in 1908 and 1909). — Trudy Troitsko-Savsko-Kyakhtinskogo Otdeleniya Priamurskogo Otdela Imperatorskogo Russkogo Geograficheskogo Obshchestva, 12(1—2):108—113. SPb. 1909.

Of the 109 fungal species reported, 3 are rusts (p. 113)

Kartavenko, N.T. O Coleosporium pinicola na sibirskom kedre na Urale (**Coleosporium pinicola** on Siberian Stone Pine in the Urals). — Bot. mater. Otd. spor. rast. Bot. Inst. AN SSSR, Vol. 9:139—141. 1953.

Coleosporium pinicola (Arth.) Jacks. was found on the Needles of Stone Pine Stands in the Ivdel' District, Sverdlovsk Region (Northern Urals).

Kasperovich, Z.S. Vliyanie geograficheskogo faktora na izmenenie ustoichivosti u sortov pshenits k razlichnym vidam golovni i rzhavchin (Effect of the Geographical Factor on the Change of Resistance of Wheat Varieties to Different Species of Smut and Rusts). Candidate Thesis, Leningrad. 1951.

Kasperovich, Z.S. Vliyanie vnekornevogo pitaniya na snizhenie zabolevanii zernovykh kul'tur (Effect of Leaf Feeding on the Reduction of Disease Incidence in Grain Crops). — In book: "Vnekornevaya podkormka sel'skokhozyaistvennykh rastenii," pp. 271—275, Moskva, Sel'khozgiz. 1955.

Kastal'skii, G. Imperatorskogo Vol'no-ekonomicheskogo obshchestva travnik okrestnostei S.-Peterburga, sobrannyi Kastal'skim (The Herbarium of the Imperial Free-Economic Society Collected in the Environs of St. Petersburg by Kastal'skii). SPb. 1847. 67 p.

Of the 93 fungal species listed, 14 are rusts.

Kastory, A. Materialy do mykologii Bialej Rusi. Na podstawie zbioru B. Namyslowskiego. — Sprawozd. Komisii fiziograf. Akad. Umiejetnośći w Krakowie, Vol. 66:101—110. 1912.

Fifty-one species of rust fungi collected in the former Vitebsk, Mogilev and Smolensk provinces are described. Part of the material (Nos. 55—105) was published by Raciborski in "Mycotheca Polonica" (fasc. IV).

Kataev, I.A. O nekotorykh rzhavchinnykh gribakh na zlakakh Turkmenskoi SSR (Some Rust Fungi on Cereals in the Turkmenian SSR). — DAN SSSR, 59(2):351—354. 1948.

On secondary hosts of **Puccinia isiaceae** (Thüm.) Winter, **P. cynodontis** Desmaz. and **P. aristidae** Tracy.

Kataev, I.A. K vidovomu sostavu rzhavchinnykh gribov Turkmenistana (Species Composition of Rust Fungi in Turkmenistan). — Izvestiya Turkmenskogo Filiala AN SSSR, No. 2 : 50—54. 1949a.

Kataev, I.A. Mikologicheskaya nakhodka v gorakh Kopet-Daga (Mycological Findings in the Mountains of Kopet-Dag). — Botanicheskii Zhurnal SSSR, 34(5): 540—541. 1949b.

On Puccinia chondrillae Corda, collected by K. V. Blinovskii from Lactuca orientalis L. in the mountains of eastern Kopet-Dag.

Kataev, I.A. Novye vidy rzhavchinnykh gribov iz Turkmenskoi SSR (New Species of Rust Fungi from the Turkmenian SSR). — Bot. mater. Otd. spor. rast. Bot. Inst. AN SSSR, 7 : 170—177. 1951a.

Aecidium pedicularis, A. batrachii, A. consolidae, Uromyces triseti, U. phalaridicola, Puccinia teucricola, P. kopetdaghensis, P. heterospora, P. heterospora-valerianae are described.

Kataev, I.A. Rzhavchinnye griby Turkmenistana (Rust Fungi of Turkmenistan). — Izvestiya Turkmenskogo Filiala AN SSSR, No. 1 : 32—38. 1951b.

The list comprises 35 species of rust fungi collected by the author in 1949—1950, on 45 species of flowering plants. New species for the USSR are: Phragmidium bayatii Est. et Petr., Puccinia baschamica Petr. and others.

Kataev, I.A. Novyi vid rzhavchinnogo griba (New Species of Rust Fungi). — Bot. mater. Otd. spor. rast. Bot. Inst. AN SSSR, Vol. 8 : 111—113. 1952a.

Uromyces turcomanicum Katajev on Muscari leucostomum G. Voron. uredo- and teliospores on Hordeum bulbosum L.

Kataev, I.A. Osobennosti razvitiya nekotorykh rzhavchinnykh gribov, parazitiruyushchikh na zlakakh v Turkmenistane (Developmental Characteristics of Some Rust Fungi Parasitic on Cereals in Turkmenistan). — Izvestiya Akademii Nauk Turkmenskoi SSR, No. 6 : 28—35. 1952b.

Kataev, I.A. Bolezni dekorativnykh rastenii goroda Kishineva i mery bor'by s nimi (Diseases of Ornamental Plants in Kishinev and Means of Combating Them). — Uchenye Zapiski Kishinevskogo Gosudarstvennogo Universiteta, Vol. 13 : 209—212. 1954.

Phragmidium subcorticum Wint., Puccinia antirrhini D. et H., P. malvacearum Mont.

Kazakevich, L.I. and A.A. Prisyazhnyuk. Materialy k mikologicheskoi flore Nizhnego Povolzh'ya (Data on the Mycoflora of the Lower Volga Region). — Trudy po Lekarstvennym i Aromaticheskim Rasteniyam, Vol. 1 : 131—156. 1932.

More than 100 species of rust fungi are listed.

Kazanovskii, V.I. Otchety (o sborakh po kriptogamnoi flore v Podol'skoi gub., v uezdakh Letichevskom, Yampol'skom i Mogilevskom (po Dnestru)) (Reports on Collections of the Cryptogmic Flora in the Podol'sk Province, and in the Letichev, Yampol' and Mogilev Counties (along the Dniester)). — Protokoly zasedanii Kievskogo obshchestva estestvoispytatelei za 1911 g. pp. 14—17, Kiev. 1912.

Forty species of rust fungi.

Kazanovskii, V.I. Otchet o rabotakh mikologicheskogo otdeleniya Kievskoi stantsii po bor'be s vreditelyami rastenii za 1914 god. Nablyudeniya nad gribnymi vreditelyami rastenii v Kievskoi gub. (Report on the Work of the Mycological Division of the Kiev Station for Plant Pest Control in 1914. Observations on Fungal Plant Pests in Kiev Province). pp. 68—82. 1915.

A detailed description of some rust fungi. Illustrations of Puccinia glumarum (II and III). There is also a Table showing the effects of rusts upon the yield of different wheat varieties.

Kazenas, L.D. Bolezni plodovykh i yagodnykh kul'tur Alma-Atinskoi zony plodovodstva (Diseases of Fruit and Berry Crops in the Arable Zone of Alma-Ata). — Trudy Respublikanskoi Stantsii Zashchity Rastenii, Vol. 1 : 179—257, Alma-Ata. 1953.

Kaznovskii, L. Zheltaya rzhavchina pshenitsy (Puccinia glumarum Erickss. et Henn.) po nablyudeniyam 1914 goda (Yellow Rust of Wheat (Puccinia glumarum Erickss. et Henn.) as Recorded in 1914). — Khozyaistvo, Vol. 9 : 944—950, Kiev. 1914.

Kaznovskii, L. Materialy po mikoflore okrestnostei m. Smely Kievsk. gub.: sbory 1913 goda. Iz rabot mikol. labor. Vseross. obshch. sakharozavodch. v m. Smele Kievsk. gub. (Data on Mycoflora in the Environs of Smela, Kiev Province, from Material Collected in 1913). — Trudy Byuro po Prikladnoi Botanike, Vol. 8 : 929—958. 1915.

Fifty-nine species of rust fungi are listed.

Kern, E.E. Caeoma pinitorquum A. Br., rastitel'nyi parazit sosny (The Pine Parasite Caeoma pinitorquum A. Br.). — Lesnoi Zhurnal, 13(10): 523—529. 1883.

Kern, E.E. K voprosu o Caeoma pinitorquum A. Br. (Caeoma pinitorquum A. Br.). — Lesnoi Zhurnal, 16(2): 140. 1886a.

Kern, E.E. Neskol'ko slov o Peridermium pini, sosnovom rzhavchinnike (A Few Words on the Pine Rust, Peridermium pini). — Lesnoi Zhurnal, 16(5): 503. 1886b.

Kern, E.E. K voprosu ob Aecidium pini, sosnovom rzhavchinnike (On Pine Rust Aecidium pini). — Lesnoi Zhurnal, 25 (6) : 105—109. 1895.

Kharkevych, H. S. Materialy do mikoflory Botanichnoho sadu Akademiyi Nauk URSR (Data on the Mycoflora in the Botanical Gardens of the Academy of Sciences of the Ukrainian SSR). — Stud. Nauk. Pratsi, zbirn. IX, Kyyivs'k. Derzh. Univ., pp. 91—104. 1949. [In Ukrainian.]

The list includes 28 species of rust fungi.

Khazaradze, E. Osnovnye zabolevaniya zernoykh kul'tur v usloviyakh Gruz. SSR i mery bor'by s nimi (The Main Grain Diseases in the Georgian SSR and Means of Combating Them). Synopses of Reports. — Nauchnaya konferentsiya Fakul'teta zashchity rastenii Gruzinskogo sel'skokhozyaistvennogo instituta, pp. 71—75. 1940.

Khokhryakov, M.K. Spetsializatsiya vidov rzhavchiny khlebnykh zlakov v Nechernozemnoi polose Evropeiskoi chasti SSSR (Specialization of Grain Rusts in the Non-Chernozem Belt of the European Part of the USSR). — Vestnik Zashchity Rastenii, No. 3 : 222—234. 1951.

Kikoina, R.I. Rzhavchina khlebov i mery bor'by s neyu (Grain Rusts and Measures of Control). — Rostov-na-Donu, Azovo-Chernomorskoe Izd. 1935. 40 p. Ill.

Kikoina, R.I. Rzhavchina pshenitsy v Azovo-Chernomor'e i Severo-Kavkazskom krae i mery bor'by s neyu (Wheat Rusts and their Control in the Region of the Sea of Azov, the Black Sea and the North Caucasus Territory). — Itogi nauchno-issledovatel'skikh rabot VIZR za 1935 g., pp. 101—103. 1936a.

Kimental', D. F., V.K. Zazhurilo, and M. V. Gorlenko. Usovershenstvovanie metodiki ucheta porazhaemosti ovsa koronchatoi rzhavchinoi (Improved Methods of Assessing Infection of Oats with Rust Fungi). — Itogi nauchno-issledovatel'skikh rabot VIZR za 1935 g., pp. 180—182. 1936.

Kleiner, B. D. Bolezni archi (Diseases of the Juniper). — Nauchnye Trudy Sredne-Aziatskogo Nauchno-Isledovatel'skogo Instituta Lesnogo Khozyaistva, Nos. 1—2 : 51—54. 1951a.

Gymnosporangium turkestanicum, G. fusisporum and Gymnosporangium sp. are reported.

Kleiner, B. D. Bolezni mindalya, proizrastayushchego v gornykh raionakh Uzbekistana (Diseases of Almond Trees Growing in the Mountainous Areas of Uzbekistan). — Lesnoe Khozyaistvo, No. 9 : 81—84. 1951b.

Nine diseases of almond trees are described, among them those caused by the fungus Puccinia pruni-spinosae Pers.

Kleiner, B.D. Bolezni fistashki v Uzbekistane (Diseases of Pistachia in Uzbekistan). — Lesnoe Khozyaistvo, No. 4 : 54—55. 1953.

Klykova, Z.D. Predvaritel'naya svodka dannykh o rzhavchine i golovne v Dal'ne-Vostochnoi oblasti za leto 1925 g. (Preliminary Summary of Data on Rusts and Smuts in the Far Eastern Regions in the Summer of 1925). — Izvestiya Amurskoi Oblastnoi Sel'skokhozyaistvennoi Stantsiii, 2 (10—12) : 159—163. 1925.

No names of rust species on cereals are mentioned.

Knyazhetskii, B.V. Glavneishie bolezni i vrediteli plodov i semyan i mery bor'by s nimi (The Main Diseases and Pests of Fruits and Seeds and their Control). Moskva-Leningrad. 1949. 52 p.

Brief description of Pucciniastrum padi Diet. and Chrysomyxa pirolae Rostr.

Kochkin, S.A. Zheltaya rzhavchina ozimoi pshenitsy v Issyk-Kul'skoi kotlovine (Yellow Rust of Fall Wheat in the Issyk-Kul Basin). — Selektsiya i Semenovodstvo, No. 10 : 57—58. 1949.

The effects of rust on wheat yield are reported. The yield of certain varieties was reduced by 17.4 centners per hectare.

Kokin, A.Ya. Fiziologicheskie obosnovaniya vredonosnosti rzhavchiny (Physiological Basis of Rust-Induced Injury). — In book: "Rzhavchina zernovykh kul'tur." Raboty I Vsesoyuznoi konferentsii po bor'be s rzhavchinoi zernovykh kul'tur, VASKHNIL, pp. 210—212. (1938) 1939.

Kokin, A.Ya. and Kh.S. Tumarikson. Fiziologicheskoe obosnovanie vredonosti rzhavchiny ovsa Puccinia coronifera Kleb (Physiological Basis of the Injury Caused to Oats by the Crown Rust Puccinia coronifera Kleb). — Trudy po Zashchite Rastenii, II Ser., No. 6 : 5—34. 1934a. With 13 illustrations.

Kokin, A.Ya. and S.T. Tumarikson. K voprosu o fiziologicheskom obosnovanii vredonostnosti rzhavchiny (The Physiological Basis of Injuries Caused by Rusts). Leningrad. 1934b. 56 p.

Kolosov, Yu.M. Ocherk vreditelei Urala, nablyudaemykh v sel'skom khozyaistve (Survey of Agricultural Pests in the Urals). — Rezul'taty ankety Ural'skogo obshchestva lyubitelei estestvoznaniya za 1915 g. i Zapiski Ural'skogo Obshchestva Lyubitelei Estestvoznaniya 36 (1—4) : 45—58. 1916.

The author reports grain rusts.

Komarov, V.L. Parazitnye griby gornogo Zeravshana (Parasitic Fungi in Mountainous Zeravshan). — Botanicheskie Zapiski izdavaemye pri Botanicheskom Sade Imperatorskogo Sankt Peterburgskogo Universiteta, 4 (2) : 233—274. 1895.

The following 12 new species are described: Uromyces ciliatus, Puccinia sogdiana, P. plicata, P. longirostris, P. monticola, P. eremuri, P. cristata, P. frigida, Aecidium lagochili, A. tulipae, A. bulbocodii, A. ixiolirionis. Many of the species are described extensively.

Komarov, V. L. O novom rode rzhavchinnykh gribov — Pucciniostele Tranzschel et Komar (A New Genus of Rust Fungi — Pucciniostele Tranzschel et Komar). — Trudy Imperatorskogo Sankt Peterburgskogo Obshchestva Estestvoispytatelei, Vol. 30, No. 1 (protokoly zasedanii), No. 4, pp. 135—140. April—May, 1899.

Komarov, V. L. Rzhavchinniki (Uredinales) Dal'nego Vostoka (Rusts (Uredinales) of the Far East). 1926. 48 p.

The author's collections for the years 1895—1898, 1913 and 1918; in all, more than 216 species (according to Komarov, 1928).

Komirnaya, O. N. Mikoflora i gribnye zabolevaniya rastenii gos. lesnoi polosy Saratov-Kamyshin (Mycoflora and Fungal Diseases of Plants in the Saratov-Kamyshin National Forest Belt). — Uchenye Zapiski Saratovskogo Gosudarstvennogo Universiteta, Vol. 29, pp. 353—376. 1952.

The dates of collection and the habitat of the host plants accompany the list of 77 species of rust fungi. Bibliography contains 19 references.

Konarzhevskii, S. Opyt bor'by s rzhavchinnikom (Experimental Control of Rusts). — Lesnoi Zhurnal, 28 (4): 834—846. 1898.

The distribution of Peridermium pini as recorded by the author and several other specialists; the primary control measure recommended is removal of infected trees.

Kon'kova, R. D. Dikie zlaki kak peredatchiki steblevoi rzhavchiny na kul'turnye zlaki (Wild Cereals as Stem-Rust Carriers of Cultivated Cereals). — Trudy Gorskogo Sel'skokhozyaistvennogo Instituta, 3 (11): 139—153. 1940.

Results of experimental infections are reported.

Korbonskaya, Ya. I. Nekotorye itogi izucheniya rzhavchinnykh gribov Tadzhikistana (Some Results of the Investigation of Rust Fungi in Tadzhikistan). — Soobshcheniya Tadzhikistanskogo Filiala AN SSSR, Vol. 9: 13—15. 1948.

Twenty-one species of rusts on different host plans, not mentioned in "Survey" of V. G. Tranzschel, are presented. The new species: Puccinia baldshuanica on Polygonum baldshuanicum Rgl. and Uromyces songorica on Euphorbia canescens L. are described.

Korbonskaya, Ya.I. Rzhavchinnye griby Tadzhikskoi SSR (Rust Fungi of the Tadzhik SSR). Candidate Thesis, Leningrad. 1949. 8 p.

Korbonskaya, Ya.I. Rzhavchina eremurusov v svyazi s voprosom dekorativnogo tsvetovodstva (Rusts of Eremurus in Connection with the Cultivation of Ornamental Flowers). — Doklady Akademii Nauk Tadzhikskoi SSR, No. 1 : 31—34. 1951a.

Korbonskaya, Ya.I. Novye vidy rzhavchinnykh gribov iz Tadzhikskoi SSR (New Species of Rust Fungi in the Tadzhik SSR). — Bot. mater. Otd. spor. rast. Bot. inst. AN SSSR, Vol. 7 : 178—181. 1951b.

The new species, Uromyces cobresiae, U. chaetolimonis, Puccinia baldshuanica, are described.

Korbonskaya, Ya.I. Rzhavchinnye griby Tadzhikistana (Rust Fungi of Tadzhikistan). — Trudy Instituta Botaniki Tadzhikskoi AN, Vol. 30 : 1—96. 1954. With 33 illustrations.

Bibliography contains 69 references.

Korzhinskii, S. Uredineae Kazanskoi gubernii (Uredineae of Kazan Province). — Trudy Obshchestva Estestvoispytatelei pri Imperatorskom Kazanskom Universitete, 13 (6) : 1—25. 1885.

Distribution of 73 species of rust fungi reported; critical comments (in Latin) accompany some of the species.

Koshkelova, E.N. Mikoflora osnovnykh floristicheskikh raionov Kopet-Data (The Mycoflora of the Principal Floristic Areas of Kopet-Dag). Synopses of Reports, Leningrad. 1955. 23 p.

Of the 166 species of rust fungi detected, the host plants of 11 species are listed. The name of the new specie is given without mentioning the host plant. The largest number of species (predominantly Hemiforms) are found at altitudes of 700—1,500 m.

Kosobutskii, M.I. Bolezni lyutserny (Diseases of Alfalfa). — Byulleten' Sredne-Aziatskogo Nauchno-Issledovatel'skogo Khimicheskogo Instituta, Nos. 4—5 : 133—152. 1934.

Observations on the development of Uromyces striatus Schr.

Kotova, E.P. Rzhavchina khlebnykh zlakov. Prognoz ozhidaemogo razvitiya glavneishikh vreditelei i boleznei s.-kh. kul'tur i lesa v 1935 gody (Grain Rusts. Forecasts of Expected Development of the Main Pests and Diseases of Agricultural Crops and Forests in 1935). — Sektor sluzhby ucheta i raionirovanniya VIZR, pp. 110—123, Leningrad. 1935a.

Kotova, E. P. Bor'bu s rzhavchinoi zernovykh kul'tur na planovyi put' (Planned Control of Grain Rusts). — Na Zashchitu Urozhaya, No. 8 : 13—14. 1935b.

Kotova, E.P. Rzhavchina zernovykh khlebov za 1934—1935 gg. (Grain Rusts in the Years 1934—1935). — Glavneishie vrediteli i bolezni sel'skokhozyaistvennykh kul'tur v SSSR (obzor za 1935 g.), pp. 118—146, Leningrad. 1936.

Kotova, E.P. Rzhavchina zernovykh khlebov (Grain Rusts). — Itogi nauchno-issledovatel'skikh rabot VIZR za 1936 g. I. Vrediteli i bolezni zernovykh kul'tur i polezashchitnykh polos, pp. 140—142. 1937a.

Kotova, E.P. Rzhavchina zernovykh khlebov (Grain Rusts). — Obzor razvitiya vreditelei i boleznei sel'skokhozyaistvennykh kul'tur za 1936 g., pp. 115—135, Izd. VASKHNIL. 1937b.

Kotova, E.P. Geograficheskoe rasprostranenie razlichnykh vidov rzhavchinnykh gribov (Geographical Distribution of Different Rust Species). — In book: "Rzhavchina zernovykh kul'tur." Raboty I Vsesoyuznoi konferentsii po bor'be s rzhavchinoi zernovykh kul'tur, pp. 42—57, Leningrad, Izd. VASKHNIL. (1938) 1939.

Koval'kovskii, A. Massovoe porazhenie Aecidium strobilinum elovykh shishek v Kostromskom uezde (Mass Infection of Spruce Cones with Aecidium strobilinum in Kostroma County). — Lesopromyshlennyi Vestnik, No. 26 : 238. 1906.

Kraft, V. L. Mikroskopicheskie nablyudeniya nad rozh'yu v nezdorovom ee sostoyanii (Microscopic Examinations of Diseased Rye). — Tekhnologicheskii Zhurnal, 2(4) : 35—48. 1805. 2 plates.

Data compiled by I. Banks on grain rust (Puccinia graminis).

Kravtsev, B.I. Gribnye bolezni sibirskoi pikhty (Fungal Diseases of the Siberian Fir). Omsk. 1933. 30 p.

Kravtsev, B.I. Gribnye bolezni tyan'shan'skoi eli (Fungal Diseases of the Tien-Shan Spruce). — Trudy Alma-Atinskogo Gosudarstvennogo Zapovednika, Vol. 7 : 122—134. 1948a.

Chrysomyxa abietis (Wallr.) Unger is reported (according to Zaprometov); Ch. Weirii Jacks. — the fungus described in North America — infects less than 1% of the trunks; Ch. deformans (Diet.) Jacz. infects up to 12% of the trunks; Thekopsora padi (Kze. et Schm.) Kleb. infects up to 10% of the cones.

Kravtsev, B.I. Gribnye bolezni dikoi yabloni (Fungal Diseases of the Wild Apple). — Trudy Alma-Atinskogo Gosudarstvennogo Zapovednika, Vol. 7 : 135—144. 1948b.

Gymnosporangium juniperinum is reported; on trees older than 10 years, infection does not exceed 9%; according to the author the fungus causes almost no damage.

Kravtsev, B.I. Gribnye bolezni topolei v Kazakhstane (Fungal Diseases of the Poplar in Kazakhstan). — Izv. AN KazSSR, Seriya Botaniki, Vol. 5 : 106 — 130. 1950.

Report on Melampsora populina (Pers.) Lév. (s.l.), M. pruinosae Tranz., M. tremulae Tul. (s.l.); Dariuca sp. in uredia on Melampsora sp.

Kravtsev, B.I. Gribnye bolezni saksaula (Fungal Diseases of Haloxylon). — Trudy Instituta Botaniki AN Kaz. SSR, Vol. 2 : 116. 1955.

Uromyces (Uredo) haloxyli B. Kravtz.

Krivitskii, A.I. Priemy kul'tury podsolnechnika v Biiskom okruge (Culture Methods of Sunflower in Biya District). — Masloboino-Zhirovoe Delo, 7(48) : 55 — 56. 1929.

Brief account of rust infections of sunflowers.

Kuda, Ya.M. Khvoroby lisu Shepetivs'koho massyvu na Volyni za 1925 rik (Forest Diseases of the Shepetovka Massif (Volhynia) in 1925). — Tr. po lisov. dosvid. sprav. na Ukrayini, Vol. 6 : 1 — 45. 1926. (Preprint).

Reports on the damage caused by Armillaria and different agarics. "Peridermium strobi Kleb." is reported on Pinus strobus.

Kuprevich, V.F. Griby Smolevichskogo r-na (BSSR) (Fungi of Smolevichi District (Belorussian SSR)). — Materialy k Izucheniyu Flory i Fauny BSSR, Vol. 6 : 24, Minsk. 1931. [In Belorussian.] See also: Savetskaya Kraina, No. 2 : 64 — 78. 1931.

Of the 237 fungi listed, 3 are rusts.

Kuprevich, V.F. Vidy Thekopsora na vishne i cheremukhe (Species of Thekopsora on Cherry and Bird Cherry Trees). — Trudy Botanicheskogo Instituta AN SSSR, Seriya II, Sporovye rasteniya, Vol. 1 : 405 — 408. 1933.

Thekopsora padi Kleb. and Th. pseudocerasi Hirats are described.

Kuprevich, V.F. K fiziologii bol'nogo rasteniya. Fiziologicheskie dannye o vredonosnosti nekotorykh gribnykh i virusnykh boleznei kul'tiviruemykh rastenii (The Physiology of Diseased Plants. Physiological Data on the Injury Caused by Certain Fungal and Viral Diseases of Cultivated Plants). Leningrad. 1934. 71 p.

The effects of rust fungi on physiological processes of infected plants.

Kuprevich, V.F. Brachy-formy roda Puccinia Pers. (Uredinales), parazitiruyushchie na vidakh gruppy Anthemideae sem. Compositae (Brachy-forms of Genus Puccinia Pers. (Uredinales) which Parasitize on Species of the Group Antemideae fam. Compositae). — Trudy Botanicheskogo Instituta AN SSSR, Seriya II, Sporovye rasteniya, Vol. 2 : 377 — 410. (1934) 1935.

Detailed descriptions of 10 species of rust fungi and their distribution in the USSR are given. New species: **P. athanasiae** Tranz. et Kupr., **P. cinae** Tranz. et Kupr.

Kuprevich, V.F. Yadovitoe deistvie iona nekotorykh metallov na spory parazitnykh gribov (Toxic Effects of the Ions of Certain Metals on the Spores of Parasitic Fungi). — Zborn. prats. Inst. Biyal. AN BSSR, Vol. 6 : 5 — 20. 1936.

The effect of copper, silver and mercury ions on urediospores of Puccinia coronifera Kleb.

Kuprevich, V.F. (et al). Opredelitel' parazitnykh gribov po pitayushchim rasteniyam flory BSSR (Key to Parasitic Fungi in the Belorussian SSR, According to Plant Hosts). Minsk. 1938. 296 p.

Diagnosis of 42 species of rust fungi that parasitize cereals.

Kuprevich, V.F. K biologii listovoi rzhavchiny rzhi **Puccinia dispersa** Erickss. (Biology of the Leaf Rust of Rye **Puccinia dispersa** Erickss.). — Sovetskaya Botanika, No. 1 : 98 — 99. 1939.

Observations on the overwintering of rusts.

Kuprevich, V.F. Ekstratsellyulyarnye fermenty rzhavchinnykh i nekotorykh drugikh gribov (Exocellular Enzymes of Rusts and Other Fungi). — DAN SSSR, 26 (7) : 710 — 713. 1940a.

Enzymatic activity observed in sprouting aeciospores of **Puccinia dispersa** and urediospores of **P. coronifera**.

Kuprevich, V.F. O proiskhozhdenii i evolyutsii parazitizma u gribov (Origin and Evolution of Fungal Parasitism). — Sovetskaya Botanika, Nos. 5 — 6 : 272 — 287. 1940b.

The origin of rust fungi and their biological properties.

Kuprevich, V.F. Sravnitel'nye issledovaniya ekstratsellyulyarnykh fermentov obligatnykh parazitov (Comparative Study of Exocellular Enzymes of Obligate Parasites). — Referaty rabot uchrezhdenii Otdela biologicheskikh nauk AN SSSR za 1940 g., p. 24. 1941.

A relatively high enzymatic activity was found in sprouting aecio- and urediospores of several species of rust fungi.

Kuprevich, V.F. Usvoenie na svetu CO_2, obrazuyushchegosya v protsesse dykhaniya (Assimilation of the CO_2 Formed in the Process of Respiration). — Priroda, No. 2 : 63 — 66. 1943.

The assimilation of CO_2 formed in respiration is less intensive in plants infected by rust fungi.

Kuprevich, V. F. Fiziologiya bol'nogo rasteniya v svyazi s obshchimi voprosami parazitizma (The Physiology of Diseased Plants in Connection with the General Problem of Parasitism). Moskva-Leningrad. 1947. 300 p.

The effect of rust fungi on the accumulation of chlorophyll, photosynthesis, respiration, transpiration, carbohydrate metabolism and enzymatic system of the feeding plant. A correlation was established between the immunity to rust fungi and the life activity of the feeding tissue of the host.

Kuprevich, V. F. Novye vidy rzhavchinnykh gribov iz Tadzhikistana (New Species of Rust Fungi from Tadzhikistan). — Bot. mater. Otd. spor. rast. Bot. inst. AN SSSR, 6(7—12): 169—172. 1950.

Diagnosis of 5 new species.

Kuprevich, V. F. Bolezni rastenii ushchel'ya Kondara (Diseases of Plants in the Kondar Gorge). — In book: "Ushchel'e Kondara" (Opyt biologicheskoi monografii), pp. 401—419, Moskva-Leningrad. 1951.

A list of parasitic fungi compiled according to the plant hosts comprises 106 species of which 56 are rusts. Five new species of rust fungi are presented.

Kuprevich, V. F. Bolezni klevera i lyutserny. Opredelitel'. (Diseases of Clover and Alfalfa. A Key). Moskva-Leningrad. 1954. 180 p.

Ten species of Uromyces and Uredo lupulina on Trifolium and Medicago are reported.

Kuprianov, V. A. Rastitel'nye parazity podsolnechnika v Voronezhskoi gubernii po obsledovaniyu 1925 goda (Plant Parasites of Sunflower in the Voronezh Province in 1925). — Byulleten' Voronezhskoi Stantsii Zashchity Rastenii, Vol. 6: 11—37, Voronezh. 1926.

Puccinia helianthi reported.

Kuprianov, V. A. Obzor glavneishikh vreditelei i boleznei rastenii Voronezhskoi gubernii. Rastitel'nye parazity polya (1925—1926 gg.) (Survey of the Main Pests and Diseases of Plants in Voronezh Province. Plant Parasites of the Fields (1925—1926)). — Byulleten' Voronezhskoi Stantsii Zashchity Rastenii, Vol. 9: 29—51, Voronezh. 1927.

Rust fungi on sunflower, cereals and peas are reported.

Kuprianova, V. D. Biologicheskoe obosnovanie mer bor'by s kol'chatoi rzhavchinoi kryzhovnika i smorodiny (Biological Basis of the Control Measures against Rusts of Gooseberry and Currants). Synopses of Reports, Leningrad. 1950. 16 p.

Kursanov, L.I. K tsitologii rzhavchinnykh gribov (The Cytology of Rust Fungi). — Dnevnik XII s''ezda russkikh estestvoispytatelei i vrachei, Protokoly, pp. 528—529, Moskva. 1910b.

Kursanov, L.I. Morfologicheskie i tsitologicheskie issledovaniya v gruppe Uredineae (Studies on the Morphology and Cytology of the Group Uredineae). — Uchenye Zapiski Moskovskogo Universiteta, Otdelenie Estestvennoi Istorii, Vol. 36 : 1—228. 1915. With 21 plates and 6 tables.

The book presents: (1) the history of morphological and cytological studies, 2) studies on the primary sporophores of incomplete forms of rust fungi, 3) studies on aecidial sporulation, 4) comparative analysis of aecidial sporulation and primary pustulus of forms devoid of aecidia, 5) morphological significance of the sexual process in rust fungi, 6) evolution, 7,8) spermatia and reduction division in rusts, 9) development of peridium in aecidial sporulation. Bibliography contains 220 references.

Kursanov, L.I. K istorii razvitiya rzhavchinnikov s povtornym obrazovaniem etsidiev (The History of Development of Rusts with Repeating Aecidia). — Zhurnal Russkogo Botanicheskogo Obshchestva, (1—2): 76—90. 1916. With 2 plates and 2 tables.

Kursanov, L.I. K morfologii Uredineae (The Morphology of Uredineae). — Trudy Sektsii po Mikologii i Fitopatologii Russkogo Botanicheskogo Obshchestva, Trudy Moskovskogo Otdeleniya, Vol. 1 : 5—19. 1923. With 2 plates.

Report of studies on sporophores of Gymnosporangium juniperinum Fr., Peridemium strobi Kleb (Cronartium ribicola Dietr.), Aecidium leucospermum DC, Chrysomyxa pirolae Rostr., Uredo pirolae Winter. Nineteen original illustrations accompany the text. Bibliography incl des 19 references.

Kursanov, L.I. Mikologiya (Mycology). Leningrad. 1940. 480 p.

A review of the morphology, systematics and biology of rust fungi.

Kursanov, L.I. and S.B. Medvedeva. K voprosu ob evolyutsii parazitizma u gribov. I. Vliyanie Chrysomyxa pirolae Rostr. na stroenie i funktsii khozyaina Pirola rotundifolia L. (On the Evolution of Parasitism in Fungi. I. The Effects of Chrysomyxa pirolae Rostr. on the Structure and Functions of the Host, Pirola rotundifolilia L.). — Byulleten' Moskovskogo Obshchestva Ispytatelei Prirody, Otdelenie Biologii, 67(2): 119—128. 1938.

Kursanov, L.I., N.I. Tseshinskaya, and E.S. Klyushnikova. O stroenii i razvitii nekotorykh maloizuchennykh Uredinales s Dal'nego Vostoka (The Structure and Development of Some Little-Studied Uredinales of the Far East). — Byulleten' Moskovskogo Obshchestva

Ispytatelei Prirody, Otdelenie Biologii, 65(2):78—92. 1936.

The development and structure of Pucciniostele mandshurica Diet., Nyssopsora clavellosa (Berk.) Arth. and Nothoravenelia japonica Diet. was studied. Improved diagnosis of the Genus Pucciniostele is presented (in Latin, p. 84—85). The study was conducted on alcohol fixed material collected by V. G. Transhel in the Maritime Region.

Kushke, Yu. Novosti gribnoi flory Kavkaza (Additions to the Mycoflora of the Caucasus).— Vestnik Tiflisskogo Botanicheskogo Sada, 11(2): 88—92. 1915. (Preprint).

Six species are described and liberally annotated. The new species described are: Uromyces trifolii-echinati Kuschke on Trifolium echinatum (p. 89), Puccinia mulgedii-cacaliaefolii Kuschke on Mulgedium cacaliaefolium (p. 90) and Puccinia doronici-macrophylli Kuschke on Doronicum macrophyllum (p. 90).

Kuznetsova, R.A. Spetsializatsiya vida Puccinia glumarum i rol' zlakovykh trav v peredache infektsii na zernovye kul'tury (Specialization of the Species Puccinia glumarum and the Role of Graminous Grasses in the Transmission of Infection to Grain Crops). Synopses of Reports, Leningrad. 1955. 21 p.

The species composition of the rust's main hosts was established by experimental infections. Highly resistant and immune grasses were detected. Development of the fungi under observation is reported.

Kuznetsova, V.A. Listovye rzhavchiny khlebnykh zlakov i usloviya vneshnei sredy (Leaf Rusts of Grains and Environmental Conditions).— Sbornik studencheskikh nauchno-issledovatel'skikh rabot Belotserkovskogo sel'skokhozyaistvennogo instituta, Vol. 1: 14—20. 1954.

Kvashnina, E.S. Predvaritel'nye soobshcheniya ob obsledovanii boleznei lekarstvennykh i tekhnicheskikh kul'tur na Severnom Kavkaze (Preliminary Report on Inspection of Medicinal and Industrial Crops in the North Caucasus).— Izvestiya Severo-Kavkazskoi Kraevoi Stantsii Zashchity Rastenii, No. 4: 29—46, Rostov-na-Donu. 1928.

Four rust species are reported. Bibliography contains 14 refs.

Lashchevskaya, V.I. K voprosu o proiskhozhdenii flory Kursko-Orlovskogo plato. Puccinia drabae Kud. na Schivereckia podolica (Bess.) Andrz. (Origin of Flora of the Kursk-Orel Plateau. Puccinia drabae Kud. on Schivereckia podolica (Bess.)).— Trudy Nauchno-Issledovatel'skogo Instituta pri Voronezhskom Gosudarstvennom Universitete, No. 1: 74—96. 1927.

Diagnosis of Puccinia drabae on the new host Schivereckia podolica; drawings of teliospores (p. 77) and a photograph of the infected plant. In the author's opinion the finding of Puccinia drabae on Schivereckia

indicates the proximity of the genera Draba and Schivereckia. Bibliography contains 56 references of which 20 are in Russian.

Lashchevskaya, V. I. Mikoflora kharakternykh tsvetkovykh rastenii vnelednikovoi lesostepi TsChO (Mycoflora Characteristic of Flowering Plants of the Extraglacial Forest-Steppe in the Central Chernozem Region). — Ibid., No. 4 : 131—148. 1930.

Melampsorium betulinum and Puccinia bullata are described.

Lavits'ka, Z. G. Materialy do mikoflory Kiyivs'koi oblasti (Data on Mycoflora in the Kiev Region). — Kiyivs'k. Derzh. Univ., Zbirn. Prats' Kanivs'k. Biogeograf. Zapovidn., 1(3): 20—24. 1947.

Lavits'ka, Z. G. Holovnishi parazitni hryby raionu Kanivs'koho bioheohrafichnoho zapovidnika (Parasitic Blight Fungi in the Kanev Biogeographical Forest Reserve). — Trudy Kanivs'k. Biogeograf. Zapovidn., No. 7: 27—45. 1949.

Of the 213 fungal species reported, 64 species belong to Uredinales.

Lavits'ka, Z. G. Parazitni hryby zilnyastykh dekaratyvnykh roslyn pravoberezhnoho lisostepu (Parasitic Fungi of Ornamental Green Plants of the Right-Bank Forest-Steppe). — Trudy Kanivs'k. Biogeograf. Zapovidn., No. 8 : 93—113. 1950.

Ten species of rust fungi are reported including Uromyces lupinicola Bub., Puccinia clarkiae Peck on Godetia amoena Lehm. Bibliography includes 33 references.

Lavits'ka, Z. G. Nova khvoroba ekhveryiyi (Echveria secunda Lindl.) u kvitnytsvakh m. Kiyiva (A New Disease of Echveria secunda Lindl. among the Flowers of Kiev). — Nauk. Zap. Kiyivs'k. Derzh. Univ., 11(10): 143—147. 1952.

Endophyllum sempervivi (Alb. et Schw.) De Bary is reported.

Lavitskaya, Z. G. Materialy k mikologicheskoi flore zapadnoi chasti Kievskoi lesostepi (Data on the Mycoflora in the Western Parts of the Kiev Forest-Steppe). — Nauk. Zap. Kiyivs'k. Derzh. Univ., 12(7): 97—114. 1953a.

Rust fungi are reported. The antagonism between Tranzschelia pruni-spinosae and Prasmopara pygmaea on Anemone ranunculoides is described.

Lavitskaya, Z. G. Fitopatologicheskaya otsenka kustarnikov, primenyaemykh dlya ozeleneniya na territorii pravoberezhnoi lesostepi (Phytopathological Study of Shrubs Adaptable to the Right-Bank Forest-Steppe). — In book: "Kievskii Gosudarstvennyi universitet, X

nauchnaya sessiya, Tezisy dokladov, sektsiya biologii," pp. 42—45, Kiev. 1953b.

Uredinales are reported.

Lavits'ka, Z. G. Ohlyad parazytnykh hrybiv zelenykh nasadzhen' mist pivdnya URSR ta raioniv Pravoberezhnoho lisostepu (Survey of Parasitic Fungi of Amenity Stands in the Southern Ukrainian SSR from the Right-Bank Forest-Steppe). — In book: "Kievskii Gosudarstvennyi universitet XI nauchnaya sessiya, Tezisy dokladov, sektsiya biologii," pp. 31—35, Kiyiv. 1954.

Puccinia anthirrini Diet. et Holm., Uromyces caryophyllinus Wint., P. arenariae (Schum.) Wint. and others are reported.

Lavitskaya, Z. G. Parazitnaya gribnnaya flora gorodskikh zelenykh nasazhdenii Ukrainskoi SSR (Parasitic Mycoflora of Urban Amenity Stands in the Ukrainian SSR). Synopses of Reports, Nauchno-koordinatsionnoe soveshchanie po zashchite zelenykh nasazhdenii ot vreditelei i boleznei, pp. 64—67, Moskva. 1955a.

Eight species of rust fungi on herbaceous ornamental stands are reported.

Lavitskaya, Z. G. Rzhavchina topolya samarkandskogo v gorodskikh nasazhdeniyakh USSR (Rusts of the Samarkand Poplar in Urban Amenity Stands of the Ukrainian SSR). Synopses of Reports. Nauchno-koordinatsionnoe soveshchanie po zashchite zelenykh nasazhdenii ot vreditelei i boleznei, pp. 75—76, Moskva. 1955b.

Lavrov, N. N. Novyi sibirskii rzhavchinnik Puccinia reverdattoana (A New Siberian Rust, Puccinia reverdattoana). — Izvestiya Tomskogo Gosudarstvennogo Universiteta, 76(1): 1—3. 1925. (Reprint).

Teliospores only are described on the leaves and stems of Macropodium nivale R. Br.

Lavrov, N. N. Rzhavchina khlebnykh zlakov v predelakh b. Tomskoi gub. i Altaya (Cereal Rusts in the Former Tomsk Province and Altai). — Byulleten' Tomskoi Agrotekhnicheskoi Sektsii Soyuza Rabotnikov Zemli i Lesa, No. 1: 3—16. 1926a.

Six species of rust fungi and some of their properties are described.

Lavrov, N. N. Material k mikoflore nizov'ev reki Eniseya i ostrovov Eniseiskogo zaliva (Data on the Mycoflora of the Lower Reaches of the Enisei River and Islands of Enisei Bay). — Izvestiya Tomskogo Gosudarstvennogo Universiteta, 76(2): 158—177. 1926b.

Rust fungi are reported.

Lavrov, N. N. Opredelitel' rastitel'nykh parazitov kul'turnykh i dikorastushchikh poleznykh rastenii Sibiri. Vypusk I. Polevye, ogorodnye, bakhchevye i tekhnicheskie kul'tury (Key to Parasites of Cultivated and Useful Wild Plants of Siberia. Part I. Field, Melon Field, Garden

and Industrial Crops). Tomsk. 1932. 148 p. With 91 illustrations.

All parasitic fungi known in Siberia (including bacterial and viral diseases) on 57 species of higher plants are described. More than 20 species of rust fungi are reported, including the new species **Puccinia hordeina** Lavr.

Lavrov, N. N. Flora gribov i slizevikov Sibiri i smezhnykh oblastei Evropy, Azii i Ameriki (The Flora of Fungi and Slime Molds of Siberia and Adjacent Areas of Europe, Asia and America). — Trudy Biologicheskogo Nauchno-Issledovatel'skogo Instituta Tomskogo Gosudarstvennogo Universiteta, Vol. 3 : 12 — 59. 1937.

A mycological bibliography of Siberia with 182 items (in foreign languages). The list of collectors contains 43 names.

Lavrov, N. N. Flora gribov i slizevikov Sibiri (Flora of Fungi and Slime Molds of Siberia). — Trudy Tomskogo Gosudarstvennogo Universiteta, Seriya Biologii, Vol. 104 : 1 — 169. 1948. With 7 plates and 77 illustrations.

Detailed diagnosis of ten rust species revealed up to that time on cereals in Siberia. New species **Puccinia hordeina** Lavr. on **Hordeum vulgare**.

Lavrov, N. N. Bolezni zernovykh kul'tur v Tomskoi oblasti i mery bor'by s nimi (Diseases of Grain Crops and their Control in the Tomsk Region). — Trudy Tomskogo Gosudarstvennogo Universiteta, Vol. 114: 125 — 130. 1951a.

General information on infections of grain crops by rust fungi.

Lavrov, N. N. Bolezni —lodovo-yagodnykh kul'tur Tomskoi oblasti i mery bor'by s nimi (Diseases of Fruit and Berry Crops in the Tomsk Region and their Control). — Ibid., Vol. 114 : 251 — 253. 1951b.

Raspberry rust is reported.

Lavrov, N. N. Bolezni klevera v Zapadnoi Sibiri (Diseases of Clover in Western Siberia). — Ibid., Vol. 117 : 143 — 146. 1952.

Species of **Uromyces** on **Trifolium**.

Lebedeva, L. A. Nablyudeniya nad razvitiem gribnykh boleznei na kul'turnykh rasteniyakh v Voronezheskoi gubernii za poslednie chisla maya i ves' iyun' tekushchego goda (Observations on Development of Fungal Diseases of Cultivated Plants in Voronezh Province towards the End of May and the Whole of June of the Current Year). — Bolezni Rastenii, 7 (3 — 4) : 183 — 188. 1913a.

Six species of rust fungi are reported.

Lebedeva, L.A. Nablyudeniya nad razvitiem gribnykh boleznei na kul'turnykh rasteniyakh v Voronezhskoi gubernii za iyul' i avgust tekushchego goda (Observations on Development of Fungal Diseases of Cultivated Plants for the Voronezh Province in July and August of the Current Year). — Ibid., 7(5—6): 326—332. 1913b.

Four species of rust fungi are reported.

Lebedeva, L.A. Vazhneishie rzhavchinnye griby nashikh kul'turnykh polevykh rastenii (The Most Important Rust Fungi of Our Field Crops). Kharkov. 1915. 25 p.

Popular pamphlet.

Lebedeva, L.A. Pervyi spisok gribov i miksomitsetov Belorussii (First List of Fungi and Myxomycetes of the Belorussian SSR). — Zapadno-Belorusskii Gosudarstvennyi Institut Sel'skogo i Lesnogo Khozyaistva, Vol. 4: 35—40. 1925a.

Seven species of rust fungi are reported.

Lebedeva, L.A. Vtoroi spisok gribov i miksomitsetov Belorussii (Second List of Fungi and Myxomycetes of the Belorussian SSR). — Ibid., Vol. 9: 1—25. 1925b. (Reprint).

The 27 species of rust fungi reported were collected in the Minsk, Bobruisk, Mozyr and Gomel districts.

Lebedeva, L.A. Rzhavchina i muchnistaya rosa khlebnykh zlakov i podsolnechnika, leto 1927 g. na Saratovsk. obl. s.-kh. stantsii (Rusts and Powdery Mildew of Cereals and Sunflower in 1927 at the Saratov Regional Agricultural Station). — Zhurnal Opytnoi Agronomii Yugovostoka, 5(2): 241—252, Saratov. 1928.

Lebedeva, L.A. Tretii spisok gribov i miksomitsetov Belorussii (Third List of Fungi and Myxomycetes of Belorussia). — Trudy Botanicheskogo Instituta AN SSSR, Seriya II, Sporovye Rasteniya, Vol. 2: 347—351. (1934) 1935.

The list is a continuation of the preceding two (see Lebedeva, 1925a and 1925b). It comprises 27 species under Nos. 241—267. Uredinales — 15 species.

Levkovskaya, G.I. Porazhaemost' zernovykh kul'tur golovnei i rzhavchinoi v zavisimosti ot sortovykh razlichii i uslovii sredy (Infectibility of Grain Crops with Blights and Rusts Correlated with the Varietal Differences and Environment). — Trudy Kirgizskoi Gosudarstvennoi Selektsionnoi Stantsii, Vol. 3: 79—118. 1948.

Field observations are reported.

Litvinov, Nik. O razlichnoi ustoichivosti yarovykh form khlebov v otnoshenii k porazheniyu ikh rzhavchinoi (Varied Resistance of Summer Grain Forms in Relation to their Infection by Rusts). — Trudy Byuro po Prikladnoi Botanike, 5(10): 347—398. 1912. With 8 plates.

Litvinov, Nik. O porazhenii yarovykh pshenits zheltoi rzhavchinoi **Puccinia glumarum** (Erickss. et Henn.) v Kamennoi Stepi v 1914 godu (Infection of Summer Wheat by Yellow Rust **Puccinia glumarum** (Erickss. et Henn.) in Kamennaya Steppe in 1914). — Ibid., 8(6): 808—813. 1915.

Lobik, A.I. Gribnye parazity, sobrannye v Kholmskom uezde Pskovskoi gubernii letom 1912—1913 g. (Fungal Parasites collected in Kholm County, Pskov Province, in 1912—1913). — Bolezni Rastenii, 8(2—3): 74—89. 1914.

Lobik, L.I. K voprosu o vliyanii parazitnykh gribkov na urozhai klevera. Predvaritel'noe soobshchenie (The Effects of Parasitic Fungi on the Yield of Clover. Preliminary Report). — Ibid., 9(4—5): 115—129. 1915. With 2 plates.

The author studied the parasitic fungi of clover in Ryazan Province in 1915. Data on **Uromyces trifollii** on clover are supplied. According to the author, comparative studies of healthy clusters with those infected by rust show that the infected clusters produce more stems and heads, and weigh more than the healthy clusters. The results reported by the author were not confirmed by further research.

Lobik, A.I. Itogi fitopatologicheskikh i mikologicheskikh obsledovanii Terskogo okruga za period 1921—1924 (Results of Phytopathological and Mycological Examinations in Terskaya District between 1921—1924). — Izvestiya Severo-Kavkazskoi Kraevoi Stantsii Zashchity Rastenii, No. 2: 19—42. 1926.

A long list of rust fungi is presented.

Lobik, A.I. Parazitnye gribki plodovykh derev'ev i mery bor'by s nimi (Parasitic Fungi of Fruit Trees and their Control). — Izvestiya Terskoi Okrestnoi Stantsii Zashchity Rastenii, Nos. 1—2: 80—83. 1927.

Bibliography contains 17 references.

Lobik, A.I. Materialy k mikologicheskoi flore plaven' reki Kumy po obsledovaniyam v 1925 godu (Data on Mycoflora at the Flooded Areas of the Kuma River according to Investigations in 1925). — Materialy po floristicheskim faunisticheskim obsledovaniyam Terskogo Okruga, pp. 13—64, Pyatigorsk. 1928.

Rust fungi are reported.

L o b i k , A. I. Obzor mikologicheskoi flory Terskogo okruga (Review of Mycoflora of the Terskaya District). — Dnevnik Vsesoyuznogo s''ezda botanikov v Leningrade v yanvare 1928 g., pp. 179—180, Leningrad. 1928.

Observations on the development of rust fungi.

L o b i k , A. I. Bolezni podsolnechnika i mery bor'by s nimi (Sunflower Diseases and their Control). Moskva-Leningrad. 1931. 72 p.

L o b i k , A. I. Sovremennoe sostoyanie voprosa o boleznyakh i povrezhdeniyakh kukuruzy na Severnom Kavkaze (Present State of Disease and Damage of Indian Corn in the Northern Caucasus). — Trudy Severo-Kavkazskogo Instituta Zashchity Rastenii (VASKHNIL), 1(8):1—48. 1933.

Detailed diagnosis and illustrations of **Puccinia maydis** Bereng., II and III; distribution in the Caucasus. Bibliography contains 108 references.

L o b i k, A. I. and V. P. R o m a n o v a. Bolezni i vrediteli plodovykh derev'ev, sredstva i mery bor'by s nimi. (Diseases and Pests of Fruit Trees and Means of Controlling them). Rostov-na-Donu. 1931. 94 p.

L o p a t i n , M. I. Izuchenie vreditelei i boleznei lyutserny i razrabotka sistemy meropriyatii po bor'be s nimi v usloviyakh Kurganskoi oblasti (Studies of Alfalfa Pests and Diseases and their Control in the Kurgan Region). — Trudy Kurganskogo Sel'skokhozyaistvennogo Instituta, Vol. 1 : 17—49. 1949.

Alfalfa rust: **Uromyces striatus**.

L o p a t i n , V. I. Bolezni lyutserny i mery bor'by s nimi (Diseases of Alfalfa and their Control). — Sotsialisticheskoe Zernovoe Khozyaistvo, No. 2 : 110—128. 1938.

Data on the development of **Uromyces striatus**.

L u g o v o i , M. Glavneishie gribnye bolezni plodovykh derev'ev i yagodnykh rastenii i mery bor'by s nimi (Main Fungal Diseases of Fruit Trees and Berries and Control Measures). Kiev. 1914. 78 p. With 74 plates.

The rusts of apple, pear, plum and currant are reported.

L u k ' y a n e n k o , P. P. O stepeni ugneteniya gibridov ozimoi pshenitsy buroi rzhavchinoi v 1932 g. v svyazi s rezul'tatami selektsii na immunitet (Measures of Suppressing the Hybrids of Winter-Wheat Brown Rust in 1932 in Relation to Results of Immunity Selection). Rostov-na-Donu. 1934. 47 p.

Luk'yanenko, P. P. Rzhavchinoustoichivye sorta ozimykh pshenits (Rust Resistance of Winter-Wheat Varieties). — Selektsiya i Semenovodstvo, 2(10): 52—55. 1935.

Luk'yanenko, P. P. O metodike selektsii sortov ozimoi pshenitsy, ustoichivykh k buroi rzhavchine (Procedures of Selection of Winter-Wheat Varieties Resistant to Brown Rust). — Yarovizatsiya, 3(36): 38—47. 1941.

A review.

Luk'yanova, E. O. O nekotorykh osobennostyakh vozbuditelya rzhavchiny podsolnechnika (Certain Characteristics of the Stimulants of Sunflower Rusts). — Sbornik studencheskikh nauchno-issledovatel'skikh rabot Sel'skokhozyaistvennoi akademii im. Timiryazeva, Vol. 1: 21—22. 1948.

The negative results obtained in infections of **Helianthus tuberosus** with spores of **Puccinia helianthi** are reported. Graftings of sunflower onto Jerusalem artichoke (**Helianthus tuberosus**) failed to raise the scion's resistance to the rust; in all experimental variants (grafts) the sunflower was severly infected.

Lysak, S. A. Original'naya forma pshenichno-rzhanogo gibrida (An Original Hybrid of Wheat Rust). — Priroda, No. 4: 120. 1955.

A hybrid was obtained from crossings of the Winter-Wheat Lesostepka 75 with the fall rye Veselopodolyanskaya. The hybrid is resistant to smut and rust.

Lyubarskii, L. V. Materialy po gribnym boleznyam lesa i razrushitelyam drevesiny v Yuzhno-Ussuriiskom krae (Data on Fungal Diseases of Forests and Destruction of Woods in the Maritime Territory). — Vestnik Dal'nevostochnogo Filiala AN SSSR, No. 9: 75—103. 1934.

Pucciniastrum (Thekopsora) padi Diet. on **Picea ajanensis** Fisch. is reported. The examination of 100 spruce cones collected at the Maikhin Institute of Forestry revealed that 7.9% of them were infected with **P. padi** Diet when the scales were thoroughly covered by aecia (p. 80). **Coleosporium pheiliodendri** Kom. on **Phelodendron amurense** Rupr.: ..." was found all over the leaves of two 4-year old saplings of Amur cork on the beds and transplanted nurseries of the Maikhin Experimental Forestry. Premature shedding of leaves was recorded every year as a consequence of this infection" (p. 96). Bibliography contains 11 references.

Lyubarskii, L. V. O gribnykh boleznyakh lesa v Zeiskom i Rukhovskom raionakh DVK (Fungal Diseases of Forests in the Zeya and Rukhovskii Districts of the Far Eastern Territory). — Vestnik Dal'nevostochnogo Filiala AN SSSR, No. 17: 79—84. 1936.

Of the 30 fungal species reported, 2 are rusts: **Peridermium pini** Kleb. and **Cronartium quercus** (Brond.) Schroet.

Lyudogovskii, A. P. and A. De Bari. O khlebnoi rzhavchine (Grain Rusts). — Sel'skokhozyaistvennyi i lesovedcheskii Zhurnal Ministerstva gosudarstvennykh imushchestv. Vol. 1: 279—304. 1865.

Lyutovskii, V. A. Fitopatologicheskie svedeniya o Kostromskoi gubernii za 1911 god. (Studies on the Phytopathology of Kostroma Province in 1911). — Bolezni Rastenii, 5(5—6): 153—156. 1911.

Thirteen rust fungi (12 species) are reported.

Maklakova, G. F. Otsenka znacheniya udobrenii i srokov seva v bor'be s rzhavchinoi zernovykh kul'tur (Estimation of the Significance of Manuring and Sowing Dates in the Control of Grain Rusts). — Itogi nauchno-issledovatel'skikh rabot VIZR za 1935 g., pp. 135—139. 1936.

Maklakova, G. F. Vliyanie udobrenii na razvitie rzhavchiny (Effect of Fertilizers on Development of Rusts). — Kratkie itogi rabot VIZR po rzhavchine khlebnykh zlakov za 1936 g., pp. 6—9, Izd. VIZR. 1937.

The application of phosphor, phosphor-potassium and potassium fertilizers failed to enhance resistance of wheat to **Puccinia triticina**.

Mal'chenko-D'yakonova, O. E. Fiziologicheskoe izuchenie vredonosnosti rzhavchiny (**Puccinia triticina** Erickss.) vysokoustoichivykh sortov pshenitsy (Physiological Studies of Rust Harmfulness (**Puccinia triticina** Erickss.) of Highly Resistant Wheat Varieties). — Itogi nauchno-issledovatel'skikh rabot VIZR za 1935 g., pp. 545—546. 1936.

Mal'chenko-D'yakonova, O. E. Fiziologicheskie obosnovanie vredonosnosti neskol'kikh ras buroi rzhavchiny pshenitsy (**Puccinia triticina** Erickss.) v svyazi s podborom ustoichivykh sortov (Physiological Basis of the Harmfulness of Certain Brown Rust Races of Wheat (**Puccinia triticina** Erickss.) in Connection with the Selection of Resistant Varieties). — Kratkie itogi rabot VIZR po rzhavchine khlebnykh zlakov za 1936 g., pp. 19—21, Izd. VIZR 1937.

The activity of oxidizing and transpiration enzymes has been established.

Mamontova, A. N. Izmenenie parazita v protsesse pitaniya na rastenii kak odna iz prichin poteri ustoichivosti sortami (Changes of the Parasite in the Course of Nutrition as a Factor in the Loss of Resistance of the Varieties). — DAN SSSR, 82(3): 493—496. 1952.

According to the author, physiological races of **Puccinia triticina** undergo changes while feeding on the host plant, following which the originally resistant host becomes susceptible to infection.

Mamontova, A. N. Ob ustoichivosti pshenitsy k buroi rzhavchine (Wheat Resistance to Brown Rust). — Agrobiologiya, No. 6: 29—30. 1953.

The author reports numerous infection experiments often performed with single-spore cultures of **Puccinia triticina**. Conclusions: "The adaptation properties of parasites feeding for several generations on a certain variety are intensified in relation to the given variety and to the immunologically related varieties." "The immunological closeness of the varieties plays a fundamental role in the adaptational variation of the parasites." "The characteristic of the variety is more stably and longer preserved by crossing forms of immunologically remote varieties sown in the given region." "Following natural pollination, hybrid wheat plants develop which facilitate adaptation of the parasite to the resistant variety" (p. 39).

Mardzhanyan, G. M. Nekotorye itogi nauchno-issledovatel'skikh rabot Sektora zashchity rastenii za 10 let (Some Results of Ten Years' Research Conducted in the Department of Plant Protection). — Izvestiya Akademii Nauk Armyanskoi SSR, Biologicheskie i Sel'skokhozyaistvennye Nauki, 6 (12): 55 — 67. 1953.

Markhaseva, V. A. Izmenchivost' proyavleniya fiziologicheskikh ras **Puccinia triticina** Erickss. v svyazi s meteorologicheskimi usloviyami (Variation in the Emergence of Physiological Races of **Puccinia triticina** Erickss. Determined by Meteorological Conditions). — Kratkie itogi rabot VIZR po rzhavchine khlebnykh zlakov za 1936 g., pp. 29 — 32, Izd. VIZR. 1937.

Markhaseva, V. A. and V. A. Sidorenko. Pro vplyv deyakykh faktoriv zovnishn'oho otochennya na rozvytoi zhovtoyi irzhi pshenytsi (The Effect of Some Environmental Factors in the Development of Yellow Wheat Rust). — Mikrobiolohichnyi Zhurnal, 15 (3) : 61 — 67. 1953. [In Ukrainian.]

Marland, A. G. and V. D. Kuprianova. Zakonomernosti razvitiya koronchatoi rzhavchiny (**Puccinia coronifera** Kleb.) ovsa v zavisimosti ot meteorologicheskikh faktorov (Patterns of Development of Oat-Crown Rust (**Puccinia coronifera** Kleb.) Correlated with Meteorological Factors). — Itogi nauchno-issledovatel'skikh rabot VIZR za 1935 g., pp. 65 — 67. 1936.

Marland, A. G. Zakonomernosti razvitiya koronchatoi rzhavchiny ovsa **Puccinia coronifera** Klev. v zavisimosti ot meteorologicheskikh faktorov (Patterns of Development of Oat-Crown **Puccinia coronifera** Kleb. Correlated with Meteorological Factors). — Kratkie itogi nauchno-issledovatel'skikh rabot VIZR po rzhavchine khlebnykh zlakov za 1936 g., pp. 25 — 29, Izd. VIZR. 1937.

Mart'yanov, N. M. Fungi **minusinensis exsiccati**. — Prilozhenie k protokolam 117 — go zasedaniya Obshchestva estestvoispytatelei pri imperatorskom Kazanskom universitete, pp. 1 — 7. 1880. (See also Protokol 86 — go zasedaniya, pp. 60 — 62. April 6, 1877.

The list comprises 51 (52) names of rust fungi collected in Sayany and the surroundings of Minusinsk.

Mart'yanov, N. M. Materialy dlya flory Minusinskogo kraya (Mycoflora of the Minusinsk Territory). — Trudy Obshchestva Estestvoispytatelei pri Imperatorskom Kazanskom Universitete, 11(3):132—146. 1882.

One hundred and sixty-eight rust fungi are listed, Nos. 933—1,100 (on pp. 132—146). The fungi are listed according to Thümen (1877, 1878, 1880a, 1880b). The article is important because it supplements the identification of the host plant species. Where Thümen left only "sp." the article, in many cases, indicates the species.

Mashtakova, K. M. Vnekornevaya podkormka kak sredstvo povysheniya urozhaya pshenitsy i snizheniya porazhaemosti ee rzhavchinoi (Leaf Feeding as a Means of Increasing Wheat Yield and Lowering the Incidence of Wheat Rust). — In book: "Vnekornevaya podkormka sel'skokhozyaistvennykh rastenii," pp. 260—263, Moskva, Sel'khozgiz. 1955.

Matsulevich, B. Materiyaly do mikoflory Volyni (Contribution to the Mycoflora of Volhynia). — Byulleten' Kievskoi Stantsii Zashchity Rastenii, Nos. 5—6:25—29. 1925. [In Ukrainian.]

Sixteen species of rust fungi are reported.

Matulyanis, P. S. K voprosu o povrezhdeniyakh sosny rzhavchinnikom (The Harmfulness of Pine Rusts). — Lesnoi Zhurnal, 27(2):248—289. 1897.

The article reports detailed observations of **Peridermium pini corticola** in the former Ozhvintskaya forestry estate of Novoaleksandrovsk (in former Kovno Province). According to the author, the disease advances around the trunk at the rate of 0.47 vershocks per year (1 vershock — 4.445 cm.) in trees ranging in age from 35 to 130 years; the duration of the disease, from the time of infection to the death of the tree, is 13 to 14 years for trees that are 35—80 years old, 20 years for those 81—100 years old, and 25 years for those 101—130 years old (p. 269). In the author's opinion, birds play a major role in spreading the disease.

Megalov, A. A. Bor'ba s vreditelyami i boleznyami sel'skokhozyaistvennykh rastenii (Control of Pests and Diseases of Agricultural Crops). Saratov. 1949. 291 p.

Diseases of cereals and other crops by rust fungi are reported. A thorough report is given with an evaluation of new data.

Melekhov, I. S. O povrezhdeniyakh elovykh lesov severnoi taigi rzhavchinnym gribom **Chrysomyxa ledi** (The Harmfulness of the Rust **Chrysomyxa ledi** for Spruce Forests in the Northern Taiga). — Sbornik Nauchno-Issledovatel'skikh Rabot Lesotekhnicheskogo Instituta, Vol. 8:59—75, Archangel'sk. 1946.

Michens, M. Ya. Vliyanie vnekornevoi podkormki na zabolevaemost' ovsa koronchatoi rzhavchinoi (The Effect of Leaf-Feeding on the Susceptibility of Oats to Crown Rust). — In book: "Vnekornevaya podkormka sel'skokhozyaistvennykh rastenii," pp. 276—277, Moskva, Sel'khozgiz. 1955.

Michurin, I. V. Novoe sredstvo protiv rzhavchiny roz (New Measures against Rose Rusts). — Professional'noe sadovodstvo i ogorodnichestvo, No. 32 : 66—70. 1905.

I. V. Michurin rubbed the stems of the infected roses with the sap of freshly-picked **Lactuca scariola L.** (lettuce) and sprayed the leaves with an aqueous infusion of same. Repeated treatment led to the disappearance of the rust.

Mikhno, P. S. Spisok gribov, khranyashchikhsya v Troitskosavskom kraevom muzee (List of Fungi Available at the Troitskosavsk (now Kyakhta) Regional Museum). 1928. 52 p.

About 370 species of fungi are reported, including the rusts determined by Tranzschel and Karsten. The fungi were collected by Mikhno in the Transbaikal (according to N. N. Lavrov, 1938, p. 52).

Minkevichus, A. Dopolnenie k obzoru rzhavchinnykh gribov Litovskoi SSR (Supplement to the Survey of Rust Fungi in the Lithuanian SSR). — Uchenye Trudy Vil'nyusskogo Gosudarstvennogo Universiteta, Seriya Estestvenno-Matematicheskikh Nauk, Vol. 1 : 141—169. 1949.

Minkevichus, A. Gribnye zabolevaniya derev'ev i kustarnikov (Fungal Diseases of Trees and Shrubs). — Izvestiya Akademii Nauk Litovskoi SSR, pp. 1—224. 1950.

A detailed description of tree and shrub rusts (in Lithuania).

Mkhitaryan, M. A. Vyyasnenie rasprostranennosti i vredonosnosti vidov rzhavchiny zernovykh v ArmSSR (Distribution and Harmfulness of Grain-Rust Species in the Armenian SSR). — Itogi rabot Armyanskoi respublikanskoi stantsii polevodstva za 1939 g., pp. 37—42. 1940.

Puccinia glumarum Erickss. et Henn. and **P. graminis** Pers are reported; according to the author, **P. glumarum** predominates. The later the grain ripening the more severe the rust damage.

Mkhitaryan, M. A. Optimal'nye sroki seva ozimoi pshenitsy, kak mera bor'by s rzhavchinoi (Optimum Data of Sowing Winter Wheat as Control Measures against Rust). — Trudy Instituta Zemledeliya AN Arm. SSR, No. 1 : 161—166. 1948.

Mkhitaryan, M. A. Ob usloviyakh sokhraneniya rzhavchinoustoichivosti sortov pshenitsy (Conditions Required for the Preservation of Rust-Resistance in Wheat Variants). — Izvestiya Akademii Nauk Arm. SSR, Biologicheskie i Sel'skokhozyaistvennye Nauki, 2 (4) : 333—345. 1949.

Bibliography on wheat resistance to rust contains 9 references. Investigations appear in the Armenian language with Russian summaries.

Mkhitaryan, M.A. Ob izmenchivosti rzhavchinoustoichivosti sortov pshenitsy (Variability of Resistance to Rusts among Wheat Varieties). — Izvestiya Akademii Nauk Arm. SSR, Biologicheskie i Sel'skokhozyaistvennye Nauki, 5(6): 35—45. 1952a.

Mkhitaryan, M.A. Bolezni polezashchitnykh lesnykh nasazhdenii Armyanskoi SSR (Diseases of Shelter Belts in the Armenian SSR). — Ibid., 5(8): 55—69. 1952b.

About 10 species of rust fungi reported.

Mkhitaryan, M.A. Ob izmenchivosti vidov rzhavchiny khlebnykh zlakov (Variability of Cereal Rusts). — Ibid., 5(12): 13—29. 1952c.

Mkhitaryan, M.A. O vyvedenii rzhavchinoustoichivykh sortov pshenitsy (Isolation of Rust Resistant Varieties of Wheat). — Ibid., 6(9): 3—14. 1953.

Mkhitaryan, M.A. Puti vyvedeniya sortov pshenitsy, ustoichivykh k rzhavchine (Means of Isolating Rust Resistant Varieties of Wheat). — Agrobiologiya, No. 1: 100—106. 1955.

Mordvilko, A.K. Anotsiklicheskie Uredinales i ikh proiskhozhdenie (Acyclic Uredinales and their Origin). — Zashchita Rastenii, 2(7): 501—505. (1925) 1926. See also Biol. Zentrbl., Vol. 45: 217231. 1925.

According to the author, the acyclic Uredinales originate following the extinction of seccndary hosts, or when the secondary hosts have dissociated from the primary ones. For example, it is found that with the disappearance of **Berberis** sp., **Puccinia graminis** develops only urediospores.

Mordvilko, A.K. Evolyutsiya tsiklov i proiskhozhdenie geteretsii u rzhavchinnykh gribov Uredinales (Evolution of Cycles and Origin of Heteroecism in the Rust Fungi Uredinales). — Zashchita Rastenii, 2(7): 484—501. (1925) 1926. See also Zentrbl. Bakteriol., Part II, Vol. 66: 181. 1925/1926.

The author maintains that the initial forms of Uredinales are derived from Lepto-forms in which the teliospores germinate without a resting period. The plurivorous Hemi-forms (III and II) and later the monoecious Eu-forms (0—I—II—III) developed from Lepto-forms. The actual new formations are the aecidia. Heteroecism may also develop as a result of the transfer of II and III of Eu-forms onto new host plants when I remains on the initial host. The author does not agree with the initial position of the "Tranzschel pattern."

M o r o c h k o v s ' k i i , S. F. Hriby Bashkiriyi-Basidiomycetes (The Basidiomycetes of Bashkiriya). — Botanichniyi Zhurnal, AN URSR, 5(1):102—110. 1948. [In Ukrainian.]

A long list of rust fungi.

M o r o c h k o v s ' k i i , S. F. Gribnye bolezni drevesnykh i kustarnikovykh lesnykh porod v stepnoi zone Ukrainy (Fungal Diseases of Forest Trees and Shrubs in the Steppe Zone of the Ukraine). — Zashchita lesonasazhdenii ot vreditelei i boleznei, pp. 113—116, Izd. AN USSR. 1952.

Uromyces cytisi and **Tranzschelia pruni-spinosae** are reported.

M o r o c h k o v s ' k y i , S. F. Mikoflora polezakhysnykh lisonasadzhen' livoberezhnoho stepu ta lisostepu Ukrayins'koi RSR (Mycoflora of Shelter Belts of the Left-Bank Steppe in the Steppe Forest of the Ukrainian SSR). — Botanichnii Zhurnal URSR, 10(4) : 57—65. 1953. [In Ukrainian.]

Rust fungi are reported.

M o r o z o v , B. G. Obzor boleznei kul'turnykh i poleznykh dikorastushchikh rastenii v Stavropol'skom okruge za 1927 g. (Survey of Diseases of Cultivated and Wild Field Plants in the Stavropol District in 1927). — Izvestiya Stavropol'skoi Stantsii Zashchity Rastenii ot Vreditelei, Vol. 4 : 32—49, Stavropol'-Kavkazskii. 1928.

Characteristics of distribution of rust fungi on cereals, sunflower, safflower, vetch, clover and other plants.

M o r o z o v , B. G. Obzor boleznei kul'turnykh i poleznykh dikorastushchikh rastenii v Stavropol'skom okruge za 1928 g. (Survey of Diseases of Cultivated and Wild Field Plants in the Stavropol District in 1928). — Rabota Stavropol'skoi Stantsii Zashchity Rastenii, No. 4 : 1—19, Stavropol'-Kavkazskii. 1929.

M o s k o v e t s , S. M. Do mikoflory pivdnya Ukrayiny (Mycoflora of the Southern Ukraine). — Visnyk Kyyivs'koho Botanichnoho Sadu, Vol. 16 : 71—87. 1933. [In Ukrainian.]

Fifty-one species of rust fungi are listed.

M o s o l o v , N. A. Griby. Spisok gribov, naidennykh v Podol'skom uezde (Fungi. Index of Fungi Found in Podol'sk County). Second enlarged edition was published by E. P. Sheremet'eva, Moskva. 1906. 45 p.

Of the 626 species of fungi listed, Nos. 44—112 are rusts. The host plants and spore forms in which the fungi were found are described.

M u r a s h k i n s k i i , K. E. Predvaritel'nyi otchet o gribakh — vreditelyakh kul'turnykh rastenii Nizhegorodskoi rubernii v 1910 g. (Preliminary Report on Fungi Injurious to Crops in the Nizhnii Novgorod (now Gorki) Province in 1910). Nizhnii Novgorod. 30 p.

Sixteen species of rust fungi were recorded. The development and harmfulness of several rusts is reported. Date of publication not given.

Murashkinskii, K.E. Gribnye vrediteli kul'turnykh rastenii Moskovskoi gubernii v 1911 g. Rzhavchina ovsa (Fungal Pests of Crops in Moscow Province in 1911. Oat Rust). — Materialy po Izucheniyu Vreditelei Kul'turnykh Rastenii, pp. 4—28, Moskva. 1911a.

A detailed report of observations on the susceptibility of different oat varieties to **Puccinia coronifera**. The author arrives at the general conclusion that white oats are more susceptible to infection by rust than black oats. "I infected oat plants with spores from **Calamagrostis epigeios** both in the laboratory and on experimental plots. Of the three infection experiments in the laboratory, two were successful. The spore heaps appeared within 10 to 12 days. Of 6 infection experiments in the open (on 10 plots), 5 proved successful (1 doubtful). The spore heaps appeared, on an average (44 cases), within 9 days. Hence, infection of oat plants by urediospores from **Calamagrostis epigeios** may be considered proved" (p. 13).

Murashkinskii, K.E. Opisatel'nyi katalog estestvenno-istoricheskogo muzeya Nizhegorodskogo gubernskogo zemstva (Descriptive Catalogue of the Muzeum of Natural History in the Nizhnii Novgorod "Zemstvo"). — Rukovodstvo k izucheniyu prirody Nizhegorodskogo kraya, Otdel botaniki. Katalog gribov, Vol. 3 : 1—25, Nizhnii Novgorod. 1911b.

The cataligue lists 77 species of rust fungi with indications of the host plants and site of collection.

Murashkinskii, K.E. Novye vidy altaiskoi mikoflory (New Species of Altai Mycoflora). — Trudy Sibirskoi Sel'skokhozyaistvennoi Akademii, Vol. 5 : 1—3. 1925. (Preprint).

The new species, **Puccinia tshujensis** Murashkinsky on **Donthostemon perennis** (Steud) C.A. Mey. and **D. micranthus** C.A. Mey. are diagnosed in Latin (only teliospores are described).

Murashkinskii, K.E. O boleznyakh saflora (Diseases of Safflower). — Izvestiya Zapadno-Sibirskogo Otdela Russkogo Geograficheskogo Obshchestva, Vol. 5 : 173—178. 1926.

Puccinia centaureae Mart. (=**P. verruca** Thüm., =? **P. Jaczewskii** Tropova) is reported on safflower.

Murashkinskii, K.E. Novye bolezni kul'turnykh rastenii Zapadnoi Sibiri (New Diseases of Crops in Western Siberia). — Trudy Omskogo Sel'skokhozyaistvennogo Instituta, 1 (14), No. 6 : 1—28. 1935. (Preprint).

Observations on rusts of safflower (**Puccinia verruca**) and Japanese safflower (**Uromyces astragali**) are reported. "Experimental infection of safflower with rusts from **Centaurea scabiosa** were performed in 1933. On July 16, series of safflower specimens (12) (seeds received from VIR) were infected with newly-produced teliospore heaps developed on the safflower, evidently affecting both the glabrous and acicular leaves" (p. 17). The experimental data are not given in detail. Bibliography contains 56 references.

Murashkinskii, K. E. Rzhavchina khlebov v Zapadnoi Sibiri (Grain Rusts in Western Siberia). — In book: "Rzhavchina zernovykh kul'tur," Raboty I Vsesoyuznoi konferentsii po bor'be s rzhavchinoi zernovykh kul'tur, VASKHNIL, pp. 94—101. (1938) 1939.

Murashkinskii, K. E. and P. D. Kleimenov. Materialy po izucheniyu gribnykh vreditelei kul'turnoi rastitel'nosti Moskovskoi gub. (Data on Studies of Fungi Harmful to Crops in Moscow Province), Vol. 2: 1—37, Moskva. 1912.

There are three articles: 1) "Oak Rust," 2) "Potato Rot," 3) "Cabbage Clubroot."

Murashkinskii, K. E. and M. K. Ziling. Materialy po mikoflore Altaya i Sayan (Data on the Mycoflora of Altai and Sayany). — Trudy Sibirskogo Instituta Sel'skogo khozyaistva i Lesovodstva, 10(4): 361—389, Omsk. 1928a.

Among the 507 species of fungi reported are 155 rusts collected in 1924—1927 in the mountains of Kuznetsk Alatau, Altai and Sayany. The material was classified by the authors with the cooperation of Karpova, Petrak and Jaczewski 32 new species are described, of which 2 are rusts.

Murashkinskii, K. E. and M. K. Ziling. Novye vidy aziatskoi mikflory, II (New Species of Asian Mycoflora, II). — Trudy Sibirskogo Instituta Sel'skogo Khozyaistva i Lesovodstva, 9(4): 1—9, Omsk. 1928b. With 7 illustrations. (Preprint).

Among the 14 new species described is **Aecidium callianthemi** Murashk.

Mushinskii, Ya. Ya. Ekskursiya v okrestnostyakh Yur'eva (An Excursion in the Environs of Yur'ev (now Tartu)). — Trudy Botanicheskogo Sada Imperatorskogo Yur'evskogo Universiteta, 12(4): 336—338. 1911.

Several species of rust fungi on wild plant hosts.

Myers, W. M., E. R. Ausemus, F. K. S. Koo, and K. J. Hsu. Ustoichivost' k rzhavchine u pshenitsy i ovsa, vyzvannaya ioniziruyushchim izlucheniem (Resistance to Rusts Induced by Ionizing Radiation in Wheat and Oats). — In book: "Doklady inostrannykh uchenykh na

Mezhdunarodnoi konferentsii po mirnomy ispol'zovaniyu atomnoi energii (Zheneva, 1955). Primenenie rakioaktivnykh izotopov v promyshlennosti, meditsine i sel'skom khozyaistve," pp. 515—532, Izd. AN SSSR, Moskva. 1956.

Myshkovskaya, E.E. K voprosu ob issledovanii pshenits Amurskoi oblasti (Studies on Wheat of the Amur Region). — Izvestiya Amurskoi Oblastnoi Sel'skokhozyaistvennoi Opytnoi Stantsii, Vol. 7:102—107. 1925.

Reports on the analysis of rust infected wheat grains used by L. F. Rusakov (1925c) for determining rusts pathogenicity. (Quoted from N. N. Lavrov, 1938, p. 59).

Nagornyi, P.I. Gribnye vrediteli, sobrannye na kul'turnykh i dikorastushchikh rasteniyakh v Stavropol'skoi gubernii v letnie mesyatsy 1911—1912 gg. (Fungal Pathogens Collected from Cultivated and Wild Plants in Stavropol Province during the Summer of 1911 and 1912).— Bolezni Rastenii, 7(3—4):87—123. 1913.

Forty-five species of rust fungi are reported, many of them accompanied by critical comment.

Nagornyi, P.I. Otchet o deyatel'nosti Stavropol'skogo entomologicheskogo byuro za 1913 god. II. Obzor boleznei rastenii. Gribnye bolezni (Report on the Activities of the Stavropol Department of Entomology for 1914. II. Survey of Plant Diseases. Fungal Diseases), pp. 40—53, SPb. 1914.

Eleven rust species are described (p. 48).

Nagornyi, P.I. III. Obzor boleznei rastenii v 1914 godu. Otchet o deyatel'nosti Stavropol'skogo entomologicheskogo byuro za 1914 god (III. Survey of Plant Diseases in 1914. Report on the Activities of the Stavropol Department of Entomology for 1914), pp. 55—73, Petrograd. 1916a.

Eleven rust species are reported (pp. 60—61).

Nagornyi, P.I. K flore gribov Stavropol'skoi gubernii. II. Griby, sobrannye letom 1913 (Fungal Flora of Stavropol Province. II. Fungi Collected in 1913). — Materialy po Mikologicheskim Obsledovaniyam Rossii, Vol. 4:1—24. 1916b.

This is a continuation of the earlier (1913) list of fungi collected in Stavropol Province; 29 species of rust fungi are reported. Critical comments accompany several species.

Nagornyi, P.I. Spisok gribov, sobrannykh I. V. Novopokrovskim i S. Yu. Turkevichem v Stavropol'skoi guvernii letom 1915 goda (List of Fungi Collected in Stavropol Province by I. V. Novopokrovskii and S. Yu. Turkevich in 1915).— Bolezni Rastenii, 9(6):146. (1915) 1917.

Eight species of rust fungi reported.

Nagornyi, P.I. and E.M. Eristavi. Kratkii obzor boleznei rastenii v Abkhazii v 1928 g. (Brief Survey of Plant Diseases in Abkhaziya in 1928), pp. 3—28, Sukhumi. 1928.

Rust fungi are reported.

Nagornyi, P.I. and B.P. Uvarov. Tablitsy dlya opredeleniya vazhneishikh vreditelei i boleznei kul'turnykh rastenii Gruzii. I. Sad (Key for the Determination of the Most Important Pests and Diseases of Cultivated Plants in the Georgian SSR). Tiflis. 1920. 120 p. With 16 plates and drawings, predominantly of insect-pests.

Rust fungi are reported.

Nakhutsrishvili, I.G. Griby, ne izvestnye dlya mikoflory Gruzii (Fungi Unknown to the Mycoflora of the Georgian SSR). — Trudy Tbilisskogo Botanicheskogo Instituta, Vol. 13 : 105—108. 1949.

Uromyces laevis Körn on Euphorbia, **Puccinia pyrethri** Rabh. on **Chrysanthemum corymbosum** L., P. **retifera** Lindr. on **Cherophyllum bulbosum** L., P. **thesi-decurentis** (P. Henn.) Diet. on **Thesium ramosum** Hayne are reported.

Nakhutsrishvili, I.G. Parazitnaya mikoflora Samgorskoi doliny i ee okrestnostei (Parasitic Mycoflora of the Samgorsa Valley and its Environs). Candidate Thesis. 1951. 14 p.

Nakhutsrishvili, I.G. Materialy k izucheniyu parazitnoi mikoflory Samgorskoi doliny (Material for the Investigation of the Parasitic Mycoflora of Samgorsa Valley). — Trudy Tbilisskogo Botanicheskogo Instituta, Vol. 15 : 127—148. 1953.

Rust fungi are reported.

Naumov, N.A. Materialy dlya mikologicheskoi flory Rossii (Material for the Mycoflora of Russia). — Trudy Byuro po Prikladnoi Botanike, 6(11): 729—734. 1914.

The work lists 238 species of fungi, mainly from the former St. Petersburg Province, as well as the Kursk, Tula and Vilna (now Vil'nyus) Provinces, which were collected in 1911. Rust fungi are on pp. 193—195 (Nos. 97—131).

Naumov, N.A. Materialy dlya mikologicheskoi flory Rossii. II. Spisok gribov Peterburgskoi gubernii (Material for the Mycoflora of Russia. II. List of Species of St. Petersburg Province). — Trudy Byuro po Prikladnoi Botanike, 7(11): 728—734. 1914.

Thirteen species of rust fungi are reported.

Naumov, N. A. Griby Urala (Fungi of the Urals). — Zapiski Ural'skogo Obshchestva Lyubitelei Estestvoznaniya, 35(1—3): 17—48, Ekaterinburg. 1915a.

Among the 318 fungi listed, many are new species. Seven new genera are from the former Perm Province. Rust fungi on pp. 8—10 (Nos. 97—133).

Naumov, N. A. Materialy k mikologicheskoi flore Rossii. III. Spisok gribov Petrogradskoi gubernii (Material for the Mycoflora of Russia. III. List of Fungi of Petrograd Province). — Materialy po Mikologii i Fitopatologii Rossii, 1(1): 51—60. 1915b.

Rust fungi on pp. 57—58 (Nos. 363—374).

Naumov, N. A. Materialy k mikologicheskoi flore Rossii. IV. Spisok gribov Petrogradskoi gubernii, V (bez nazvaniya) (Material for the Mycoflora of Russia. IV. List of Fungi of Petrograd Province, V (title omitted)). — Materialy po Mikologii i Fitopatologii Rossii, 2(1): 32—39, 39—44. 1916.

The list includes 200 species (Nos. 408—467) of which 16 are rust fungi.

Naumov, N. A. Bolezni sadovykh i ovoshchnykh rastenii s osnovami obshchei fitopatologii (Diseases of Orchard and Vegetable Plants with Fundamentals of General Phytopathology). Moskva-Leningrad. 1934. 344 p.

Rust fungi are reported from orchard and vegetable crops. The symptoms of disease are described in detail. The fungi are not described.

Naumov, N. A. Rezul'taty issledovatel'skikh rabot VIZR i ego seti po rzhavchine khlebnykh zlakov za 1936 g. (Results of Research Conducted by VIZR on Cereal Rusts in 1936). — Kratkie itogi rabot VIZR po rzhavchine khlebnykh zlakov za 1936 g., pp. 3—5, Izd. VIZR. 1937.

Naumov, N. A. Rzhavchina khlebnykh zlakov SSSR (Grain Rusts of the USSR). Leningrad. 1939. 401 p.

Extensive bibliography (1936).

Naumov, N. A. Usloviya vozniknoveniya epifitotii rzhavchiny (Conditions Conducive for Rust Development). — In book: "Rzhavchina zernovykh kul'tur," Raboty I Vsesoyuznoi konferentsii po bor'be s rzhavchinoi zernovykh kul'tur, pp. 29—42, VASKHNIL. (1938) 1939.

Naumov, N. A. and T. L. Danilova. Griby na zheltoi akatsii **Caragana arborescens** (Fungi on **Caragana arborescens**). — Uchenye Zapiski Leningradskogo Gosudarstvennogo Universiteta, Seriya Biologicheskikh Nauk, Vol. 25: 52—69. 1950.

Uromyces cytisi (Str.) Schroet. is reported.

Naumov, N. A. and T. L. Dobrozrakov. Spisok gribov, sobrannykh v Krymu N. A. Naumovym 3—10 sentyabrya 1927 g. (List of Fungi Collected in the Crimea by N. A. Naumov, September 3—10, 1927).— Materialy po Mikologii i Fitopatologii, 8(2):133—136. (1929) 1931.

Rust fungi are reported.

Naumova, N. A. Vliyanie temperatury i vlazhnosti vozdukha na inkubatsionnyi period **Puccinia triticina** Erickss. (Effect of Temperature and Relative Humidity on the Incubation Period of **Puccinia triticina** Erickss.).— Zashchita Rastenii, 5:33—35. 1935.

Naumova, N. A. Zavisimost' razvitiya zheltoi rzhavchiny pshenitsy ot meteorologicheskikh faktorov (Development of the Yellow Rust of Wheat Correlated to Meteorological Conditions).— Itogi nauchno-issledovatel'skikh rabot VIZR za 1935 g., pp. 64—65. 1936.

Naumova, N. A. Estestvennye kolebaniya temperatury i prodolzhitel'nost' inkubatsionnogo perioda **Puccinia glumarum** f. **tritici** Erickss. et Henn. (Natural Fluctuations of Temperature and Duration of the Incubation Period of **Puccinia glumarum** f. **tritici** Erickss. et Henn.).— Zashchita Rastenii, 12:51—60. 1937.

Naumova, N. A. Vliyanie klimaticheskikh faktorov na izmenenie ustoichivosti pshenitsy k buroi rzhavchine (The Effect of Climatic Factors on the Change of Resistance of Wheat to Brown Rust).— Itogi nauchno-issledovatel'skikh rabot VIZR za 1939 g., pp. 62—64. 1939.

Naumova, N. A. K voprosu ekologicheskoi otsenki porazhaemosti pshenits buroi rzhavchinoi (Ecological Determination of Wheat Infectibility by Brown Rust).— Botanicheskii Zhurnal SSSR, 34(6):618—628. 1949.

Naumova, N. A. Vliyanie temperaturnykh uslovii rosta yarovoi pshenitsy na porazhaemost' ee buroi rzhavchinoi (Effect of the Growth Temperature of Summer Wheat on its Susceptibility to Brown-Rust Infection).— Botanicheskii Zhurnal SSSR, 36(1):39—46. 1951.

"If the sprouting-tube formation stage takes place at relatively low temperatures, the variety retains increased resistance (in many cases, full resistance) to brown-rust infection; if development takes place at relatively high temperatures, the same variety is severely attacked by brown rust in the ear-formation stage (p. 45)."

Navashin, S. G. O nakhozhdenii **Gymnosporangium tremelloides** R. Htg. pod Moskvoi (Occurrence of **Gymnosporangium tremelloides** R. Htg. in the Moscow Region).— Botanicheskie Zapiski, izdavaemye pri Botanicheskom Sade Sankt Peterburgskogo Universiteta, Vol. 2:173. 1889.

Navashin, S. G. O novoi forme **Puccinia** na **Stipa pennata** (A New Form of **Puccinia** on **Stipa pennata**). — Trudy Sankt Peterburgskogo Obshchestva Estestvoispytatelei, Otdel Botaniki. Protokoly zasedanii, p. 28. 1892.

Puccinia wolgensis Nawaschin on **Stipa pennata** from the former Saratov Province is described.

Navsuts, B. S. Bolezni drevesnykh i kustarnikovykh porod v gorodskikh nasazhdeniyakh i pitomnikakh Moskvy (Diseases of Trees and Shrubs in the Amenity Stands and Nurseries of Moscow). Synopses of Reports — Nauchno-koordinatsionnoe soveshchanie po zashchite zelenykh nasazhdenii ot vreditelei i boleznei, pp. 62—64, Moskva. 1955.

Uredinales on **Rosa** and **Betula**.

Negrutskii, S. F. Bolezni sosny i bor'ba s nimi v Khrenovskom boru (Pine Diseases and their Control in the Khrenovoe Pine Forests). Candidate Thesis, Voronezh. 1955.

Nesterchuk, G. I. Rastitel'nye parazity sosnovykh kul'tur Osinovoroshchinskoi dachi Pargolovskogo uchebno-opytnogo lesnichestva Leninradskogo lesnogo instituta (Plant Parasites of Pines in the Osinovoroshchinskaya Forest Estate of the Pargolovo Experimental Forestry Station of the Leningrad Forestry Institute). — Bolezni Rastenii, 15(1): 27—41. 1926.

Aecidia of **Coleosporium** sp. is reported.

Nesterova, K. V. Poteri ot rzhavchiny l'na (**Melampsora lini** Lév) na l'nedolguntse (Losses of Fiber Flax Caused by the Flat Rust, **Melampsora lini** Lév). — Itogi nauchno-issledovatel'skikh rabot VIZR za 1935 g., pp. 546—548. 1936.

The author examined flax fields over an area of 208,000 ha in Western Siberia, Sverdlovsk and Chelyabinsk regions and found that losses amounted to 0.7—1.2%.

Nevodovskii, G. S. Gribnye vrediteli kul'turnykh i dikorastushchikh poleznykh rastenii Kavkaza v 1911 godu. God pervyi (Fungal Pests of Cultivated and Wild Field Plants of the Caucasus in 1911. First Year). — Trudy Tiflisskogo Botanicheskogo Sada, Supplement to Vol. 11, No. 2, pp. 1—31. 1912.

Nevodovskii, G. Gribnye vrediteli kul'turnykh i dikorastushchikh poleznykh rastenii Kavkaza v 1911 godu. God vtoroi (Fungal Pests of Cultivated and Wild Field Plants of the Caucasus in 1911. Second Year). — Ibid., 7th Supplement to Vol. 12, No. 3, pp. 1—86. 1914.

About 30 species of rust fungi are reported.

Nevodovskii, G. S. Novye ili maloizuchennye vidy kazakhstanskoi mikoflory (New or Little-Known Species of the Mycoflora of Kazakhstan). — Bot. mater. Otd. spor. rast. Bot. Inst. AN SSSR, 6(7—12): 172—185. 1950.

Nevskii, S. A. Agrostologicheskie etyudy (Agrostological Studies). — Trudy Botanicheskogo Instituta AN SSSR, Seriya 1, Vol. 1 : 9—32. 1933.

Nikolaeva, M. I. Gribnye bolezni espartseta v usloviyakh Voronezhskoi oblasti i perspektivy bor'by s nimi (Fungal Diseases of Sainfoin in the Voronezh Region and their Potential Control). Candidate Thesis, Voronezh. 1953a. 15 p.

In infection experiments with **Uromyces onobrychidis**, the author was unable to infect a wide range of species belonging to the following genera: **Medicago** L., **Melilotus** Adans., **Trifolium** L. (of the tribe **Trifoliae**), **Lotus** L., (of the tribe **Loteae**), **Lathyrus** L., **Pisum** L. and **Vicia** L. (of the tribe **Viciae**).

Nikolaeva, M. I. Rzhavchina insektisidnykh romashek (Rusts of **Pyrethrum**). — Byulleten' Obshchestva Estestvoispytatelei pri Voronezhskom Gosudarstvennom Universitete, Vol. 8 : 19—22. 1953b.

Puccinia pyrethri Rabenh. is reported on **Pyrethrum**.

Nikolaeva, T. L. O nekotorykh gribakh vstrechayushchikhsya na kauchukonosakh iz roda **Chondrilla** (Certain Fungi Found on Rubber Plants of the Genus **Chondrilla**). — Trudy Botanicheskogo Instituta AN SSSR, Seriya II, Sporovye Rasteniya, Vol. 1 : 263—266. 1933.

Puccinia chondrillina on stems of **Ch. brevirostris**.

Nilova, V. P. and G. N. Egorova. Aktivnost' katalazy i peroksidazy i immunitet pshenitsy k buroi rzhavchine (**Puccinia** triticina Erickss.) (Catalase and Peroxidase Activity and Wheat Immunity to Brown Rust). — Doklady VASKHNIL, Vol. 1 : 34—38. 1948.

According to the author's data, the activity of catalase and peroxidase in resting seeds and sprouts of susceptible varieties is higher than in resistant varieties.

Nilova, V. P. and B. A. Krasner. Izmenchivost' biokhimicheskogo sostava list'ev yarovoi pshenitsy v ontogeneze rasteniya (Biochemical Changes of the Leaf Composition of Summer Wheat in the Ontogenesis of the Plant). — Trudy VIZR, No. 5 : 194—202. 1954.

The concentration of sugars, chlorophyll, nitrogen compounds and carotin rises in the leaves of summer wheat in the heading and tillering stages. Mass infestation with rusts is confined to this period.

Nilova, V. P. and V. F. Rashevskaya. O vliyanii nekotorykh elementov na izmenenie immunologicheskikh svoistv rastenii (The Effect of Some Elements on Changes of the Immune Properties of Plants). — Referaty dokladov na Konferentsii po mikroelementam, pp. 196—199. AN SSSR, 1950.

The author reports changes in the enzymatic activity of the tissues of winter wheat and at the same time of the degree of resistance to brown leaf rust on seed treatment with solutions containing N, P, K. Na, B, Mn, Zn, Cu, Mg, Fe and a mixture of NPK.

Nilova, V. P. and V. F. Rashevskaya. O vliyanii nekotorykh khimicheskikh elementov na immunologicheskie svoistva rastenii (The Effect of Certain Chemical Elements on the Immune Properties of Plants). — In book: "Mikroelementy v zhizni rastenii i zhivotnykh, Trudy Konferentsii po mikroelementam, 15 — 19 March 1950," pp. 591—602, Moskva, Izd. AN SSSR. 1952.

The effect of micro- and macroelements on the resistance of wheat to **P. triticina**.

Nilova, V. P. and V. F. Rashevskaya. Vliyanie vozrastnykh osobennostei obmena veshchestv list'ev pshenitsy na ikh vospriimchivost' k buroi rzhavchine (The Effect of Increased Specific Metabolism of the Leaves of Wheat on its Susceptibility to Brown Rust Infection). — Trudy VIZR, No. 5 : 56—61. 1954.

The experimental studies carried out by the authors show that the degree of susceptibility to rust infection of wheat is correlated with the intensity of physiological and chemical processes in the plant's tissues. Age proved to be a major factor in the physiological activity of the tissue and susceptibility to infection. It is evident that the higher the physiological activity the more pronounced the rust development (p. 61).

Nilova, V. P., V. D. Svoiskaya, and A. M. Ikonnikova. Tirozin, aktivnost tirozinazy i immunitet pshenitsy k buroi rzhavchine (**Puccinia triticina** Erickss.) (Tyrosin, Tyrosinase Activity and Immunity of Wheat to Brown Rust (**Puccinia triticina** Erickss.)). — Doklady VASKHNIL, Vol. 1 : 30—42. 1948.

According to the authors, susceptibility to **Puccinia triticina** of wheat varieties is characterized by higher tyrosinase activity (in relation to resistant varieties) in both grass seeds and sprouts. "The content of free tyrosin in seeds and sprouts of resistant varieties is significantly higher than in susceptible ones" (p. 42). The authors suggest that "the different intensity of proteolysis and oxidation of protein metabolites of the tyrosin type" determine the different resistance of wheat varieties to rusts.

Novikov, M. A. Gribnye bolezni plodovykh derev'ev (Fungal Diseases of Fruit Trees). SPb. 1913. 82 p.

N o v i k o v, M. M. Rzhavchinniki nashikh khlebnykh rastenii (Rusts of Our Cereals). — Sel'skoe Khozyaistvo i Lesovodstvo, 224 (1) : 309 — 339. 1907 and 235 (5) : 42 — 62. 1907. With 29 illustrations.

Infection experiments were carried out, especially with teliospores of **Puccinia graminis** which caused infection of **Berberis amurensis** Rupr.

N o v i k o v, V. A. Narushenie biokhimicheskogo obmena v list'yakh lyutserny pri porazhenii rzhavchinoi **Uromyces striatus** Schröt. (Disturbance of the Biochemical Metabolism in Leaves of Alfalfa Attacked by the Rust **Uromyces striatus** Schröt.). — Dokl. AN SSSR, 15 (1) : 53 — 56. 1937.

N o v i t s k i i, S. I. Promezhutochnye khozyaeva v kachestve istochnikov infektsii zlakov rzhavchinoi (Intermediate Hosts as Sources of Cereal Infections with Rusts). — Kratkie itogi rabot VIZR po rzhavchine khlebnykh zlakov za 1936 g., pp. 46 — 47, Izd. VIZR. 1937.

N o z d r a c h e v, K. G. Povarennaya sol' v bor'be s rzhavchinoi zernovykh kul'tur (Common Salt in the Control of Grain Rusts). — Zashchita Rastenii, 10 : 28 — 31. 1936.

N o z d r a c h e v, K. G. Razrabotka meropriyatii po bor'be s rzhavchinoi zernovykh kul'tur (Control Measures against Grain Rusts). — In book: "Rzhavchina zernovykh kul'tur," Raboty I Vsesoyuznoi konferentsii po bor'be s rzhavchinoi zernovykh kul'tur, pp. 236 — 247, VASKHNIL. 1938 (1939).

Obmen dubletami mikologicheskogo gerbariya Tsentral'noi fitopatologicheskoi stantsii Botanicheskogo sada (Duplicate Exchange of the Mycological Herbarium of the Central Phytopathological Station of the Botanical Gardens). — Bolezni Rastenii, Supplement, 9 (4 — 5) : 1 — 18, 1915.

The catalogue lists about 150 species of rust fungi.

O l ', I. A. Spisok gribov, sobrannykh T. Kvartskheliya letom 1912 goda v Kutaisskoi gubernii (List of Fungi Collected by T. Kvartskheli in the Summer of 1912 in Kutaisi Province). — Bolezni Rastenii, 7 (5 — 6) : 324 — 326. 1913.

Of 15 fungal species, 4 are rusts.

O l ', I. A. Gribki, sobrannye I. V. Novopokrovskim v Olbasti Voiska Donskogo (peschanye lesnichestva) v 1913 g. (primechanie k stat'e: I. V. Novopokrovskii. Rastitel'nost' voiskovykh peschanykh lesnichestv Donskoi oblasti) (Fungi Collected by I. V. Novopokrovskii in the Don Cossacks Region (Sandy Forests) in 1913. (Notes on the Article by I. V. Novopokrovskii. Vegetation of the Sandy Forest Area of the Don Cossacks Region). — Izvestiya Botanicheskogo Sada Petra Velikogo, Supplement I, Vol. 15 : 46. 1915.

Phragmidium potentillae and **Melampsora pinitorqua**.

Ostapets, A. P. Meropriyatiya po bor'be s glavneishimi vreditelyami zernovykh kul'tur (Control Measures against the Main Pests of Grain Crops). — Nauchnaya konferentsiya po izucheniyu i razvitiyu proizvoditel'nykh sil Voronezhskoi oblasti, pp. 126—128, Voronezh. 1940.

Pal'chevskii, N. A. Bolezni kul'turnykh zlakov Yuzhno-Ussuriiskogo kraya (Diseases of Grain Crops in the South Ussuri Territory). SPb. 1891. 79 and 43 p. (Supplement).

Fungi determined by M. S. Voronin. Rust fungi injurious to grain are mentioned on pp. 21 and 22, and fungi detected on different plants are listed on pp. 39—40 of the Supplement. The latter fungi served as material for the studies conducted by N. V. Sorokin and N. Bush (1892). In this work the determinations are frequently incomplete, leaving many species with the designation of "sp" only.

Parfilova, M. K. Rzhavchina pikhty v lesakh Karpat (Fir Rusts in the Carpathian Forests). — Lesnoe Khozyaistvo, No. 12 : 74—75. 1952.

Melampsorella cerastii Wint.

Petrov, I. P. Griby Moskovskoi gubernii. Pervyi spisok. (Fungi of Moscow Province. First List). — Izvestiya Imperatorskogo Sankt Peterburgskogo Botanicheskogo Sada, 10(1) : 1—20. 1910.

Nine species of rust fungi with notes.

Petrov, I. P. Griby Moskovskoi gubernii. Vtoroi spisok (Fungi of Moscow Province. Second List). — Izvestiya Imperatorskogo Sankt Peterburgskogo Botanicheskogo Sada, 11(3) : 63—73. 1911.

Two species of rust fungi.

Petrukovich, S. U. Kratkaya opisatel'naya tablitsa boleznei polevykh kul'tur po vneshnim priznakam (A Brief Descriptive Key to Diseases of Field Crops According to External Symptoms). — Informatsionnyi Byulleten' Gosudarstvennogo Komiteta po Sortoispytaniyu Zernovykh Kul'tur, 5(135) : 27—46. 1948.

Rust fungi are reported.

Petrushinskii, Z. F. Rezul'taty trudov i opytov, proizvedennykh na opytnoi stantsii v Beisagole v 1912 godu (Results of Studies and Experiments Performed at the Experimental Station in Beisagol in 1912). Vil'no. 1914.

Six species of rusts parasitic on cereals are reported.

Petrushova, N. I. Vyyavlenie fiziologicheskikh ras **Puccinia triticina** Erickss. v Leningradskoi oblasti v 1936 godu (Occurrence of Physiological Races of **Puccinia triticina** Erickss. in the Leningrad Region in 1936). — Kratkie itogi rabot VIZR po rzhavchine khlebnykh zlakov za 1936 g., pp. 13—14, Izd. VIZR. 1937.

Pidoplichka, M. M. vyznachnyk hrybiv-skidnykiv kul'turnykh roslyn (A Key to the Rust Fungi of Cultivated Plants). — Kyyiv, Izd. AN URSR, 1938. 596 p. [In Ukrainian.]

Rusts parasitizing cultivated plants are reported.

Pidoplichka, N. M. Gribnaya flora grubykh kormov (Fungal Flora of Raw Forage). Kiev. 1953. 487 p.

A detailed diagnosis of 64 species of rust fungi is presented.

Pivkina, A. F. K perezimovke na Dal'nem Vostoke lineinoi (steblevoi) rzhavchiny (**Puccinia graminis** f. sp. **tritici**) (Overwintering of the Stem Rust **Puccinia graminis** f. sp. **tritici** in the Far East). — Soobshcheniya Dal'nevostochnogo Filiala AN SSSR, Vol. 2 : 11—15. 1951.

Infection experiments have shown the possibility of renewed infection in the spring with the urediospores of **P. graminis** that overwintered on the straw. Bibliography includes 9 references.

Polishchuk, L. K. and E. I. Bogomaz. Nekotorye fiziologicheskie osobennosti kok-sagyza pri porazhenii **Puccinia taraxaci** (Rebent.) Plowr. (Certain Physiological Properties of Kok-Sagyz Attacked by **Puccinia taraxaci** (Rebent.) Plowr.). — Nauk. zap. Kyyiv, Derzh. univ., 2(5): 95—104. 1952.

Politaev, V. K voprosu ob eksploatatsii sosnovykh nasazhdenii, povrezhdennykh gribkom **Aecidium pini** (The Problem of Felling Pine Stands Damaged by **Aecidium pini**). — Lesnoi Zhurnal, 24(1): 117—121. 1894.

Data on the pathogenicity of **Peridermium pini** in the forest estates of the former Vil'no and Kovno Provinces.

Polozova, E. S. O vozmozhnosti perezimovki uredospor lineinoi rzhavchiny pshenitsy v Primorskom krae (The Possibility of Overwintering Urediospores of the Stem Rust of Wheat in the Maritime Territory). — Soobshcheniya Dal'nevostochnogo Filiala AN SSSR, Vol. 7 : 68—70. 1955.

Polyakov, I. M. Khimicheskie metody bor'by s rzhavchinoi i ikh perspektivy (Chemical Control Methods of Rusts and their Potential). — In book: "Rzhavchina zernovykh kul'tur," Raboty I Vsesoyuznoi konferentsii po bor'be s rzhavchinoi zernovykh kul'tur, pp. 258—266, VASKHNIL. (1938) 1939.

Polyakov, I. M. Predvaritel'naya otsenka khimicheskoi immunizatsii kak metoda bor'by s buroi i zheltoi rzhavchinoi pshenitsy v polevykh usloviyakh (Preliminary Estimation of Chemical Immunization as a Means of Control of Brown and Yellow Rusts of Wheat in Field Conditions). — Trudy VIZR, Vol. 2 : 171—181. 1949.

Pomasskii, A. Issledovanie khimicheskogo sostava teleitospor rzhavchiny (Studies on the Chemical Composition of Teliospores of Rusts). — Trudy Byuro po Zootekhnike, Vol. 8 : 85—105, SPb. 1912.

Popov, K. I. Znachenie vnekornevoi podkormki v bor'be s nekotorymi vreditelyami i boleznyami pshenitsy. Vnekornevaya podkormka kak metod izucheniya trebovanii rastenii k usloviyam pitaniya (The Value of Leaf-Feeding in the Control of Certain Pests and Diseases of Wheat. Leaf-Feeding as a Method of Study of the Nutritional Requirements of Plants). — In book: "Vnekornevaya podkormka sel'skokhozyaistvennykh rastenii," pp. 210—255, Moskva, Sel'khozgiz. 1955.

Popova, T. S. Bor'ba s rzhavchinoi l'na (Control of Flax Rust). — Len i Konoplya, 12 (5) : 14—17. 1935.

Popov, T. S. Bor'ba s boleznyami sakharnoi svekly (Control of Sugar-Beet Diseases). — Nauchnaya konferentsiya po izucheniyu i razvitiyu proizvoditel'nykh sil Voronezhskoi oblasti. Synopses of reports, pp. 122—125, Voronezh. 1940.

Popova, M. P. and V. P. Soboleva. Vrediteli i bolezni plodovoyagodnykh kul'tur (Pests and Diseases of Fruit and Berry Crops). 3rd edition, revised and enlarged, Moskva. 1955. 296 p.

Rust fungi of apple and pear trees, raspberry and other plants are reported.

Portaev, P. G. Epifitotiya rzhavchiny khlebov v Ordzhonikidzevskom krae (Epiphytotic of Grains of Rusts in Ordzonikidze Territory). — In book: "Rzhavchina zernovykh kul'tur," Raboty I Vsesoyuznoi konferentsii po bor'be s rzhavchinoi zernovykh kul'tur, pp. 102—104, VASKHNIL. (1938) 1939.

Pospelov, A. G. Rzhavchinnye bolezni pshenitsy i mery po bor'be s nimi v Kirgizii (Rust Diseases of Wheat and their Control in Kirgizia). Frunze. 1951a. 14 p. Illustrated.

Pospelov, A. G. Listovye rzhavchiny pshenitsy Frunzenskoi oblasti i Issyk-Kul'skoi oblasti, ikh vrednoe khozyaistvennoe znachenie i mery bor'by (Leaf Rusts of Wheat in the Frunze and Issyk-Kul Regions, the Economic Damage They Inflict and their Control). — Trudy Biologicheskogo Instituta Kirgizskogo Filiala AN SSSR, Vol. 4 : 67—69. 1951b.

According to the author's data, the yellow rust reduces the yield of winter wheat in "rusty" years by 1.1 — 19.2 centners per ha, or 3 — 50%.

Potapov, A.I. Biologicheskii metod bor'by s osotom (Biological Control Method with Sowthistle). Irkutsk. 1925. 17 p.

Observations on the effect of **Puccinia suaveolens** Rostr. on **Cirsium arvense** are described.

Potebnya, A.A. Mikromitsety Kurskoi i Khar'kovskoi gubernii (Micromycetes of Kursk and Khar'kov Provinces). — Trudy Obshchestva Ispytatelei Prirody pri Imperatorskom Khar'kovskom Universitete, Vol. 61 : 233—284. 1907. See also: Ann. mycol., Vol. 8 : 42—93.

The report includes 18 species of rust fungi with the respective plant hosts and habitats (pp. 244—247).

Potebnya, A.A. Materialy k mikologicheskoi flore Kurskoi i Khar'kovskoi gubernii (Material for the Mycoflora of Kursk and Khar'kov Provinces). — Ibid., Vol. 63 : 203—241. 1910. With 6 plates.

Rust fungi under Nos. 186—203; plant hosts, habitat and dates of collection supplied.

Pozhar, Z.A. Bolezni sakharnoi svekly i mery bor'by s nimi (Diseases of Sugar Beet and their Control). — In book: "Vrediteli i bolezni sakharnoi svekly," pp. 144—223, Moskva. 1952.

The rust of beet leaves is described.

Pozhar, Z.A. and A.Ya. Ovcharenko. Rzhavchina sakharnoi svekly i mery bor'by s nei (Sugar Beet Rust and its Control). — Trudy Vsesoyuznogo Nauchno-Issledovatel'skogo Instituta Sveklovitsy, Vol. 32 : 214—216. 1950.

Pravdin, F.N. — In book: "Kul'tura kauchukonosov" (Rubber-Plant Cultivation). Moskva. 1948. 359 p.

Control measures against **Puccinia taraxaci** Plowr. (p. 137).

Prisyazhnyuk, A.A. Materialy po izucheniyu gribnykh zabolevanii polevykh kul'tur Nizhne-Volzhskogo kraya (Material for the Study of Fungal Diseases of Field Crops in the Lower Volga Territory). — Zashchita Rastenii ot Vreditelei, 7 (1—3): 323—337. 1931.

Rust fungi are reported.

Prisyazhnyuk, A.A. Vrediteli i bolezni lesnykh polezashchitnykh nasazhdenii i mery bor'by s nimi (Pests and Diseases of Forest Shelter Belts and their Control). Moskva. 1949a. 87 p.

Melampsora pinitorqua and **Peridermium pini** are reported.

Prisyazhnyuk, A.A. Vrediteli i bolezni seyantsev i sazhentsev v agrolesomeliorativnykh pitomnikakh i mery bor'by s nimi (Pests and Diseases of Seedlings and Saplings in Agricultural and Forestry Nurseries and their Control). Moskva. 1949b. 78 p.

Pine-twisting rust and willow rust are mentioned.

Prisyazhnyuk, A. A. O porazhaemosti sortov yarovoi pshenitsy buroi listovoi rzhavchinoi i meropriyatiyakh po bor'be s nei v usloviyakh lesnykh polezashchitnykh nasazhdenii (Susceptibility of Summer Wheat Varieties to Brown Leaf Rust Infections and Control Measures under the Conditions of Forest Shelter Belt Stands). — Izv. AN BSSR, No. 1 : 131 — 135. 1951.

Pronicheva, L. L. Razrabotka agrotekhnicheskikh meropriyatii i ispol'zovanie sortovykh osobennostei v bor'be s rzhavchinoi pshenitsy (Elaboration of Agricultural Procedures and Utilization of Varietal Characteristics in the Control of Wheat Rusts). — Kratkie itogi rabot VIZR po rzhavchine khlebnykh zlakov za 1936 g., pp. 42 — 45, Izd. VIZR. 1937.

Pronicheva, L. L. Biotipy buroi rzhavchiny i ustoichivost' k nei pshenits (Biotypes of Brown Rust and Resistance of Wheat to Them). — Sotsialisticheskoe Zernovoe Khozyaistvo, No. 5 : 120 — 132. 1938.

Pronicheva, L. L. Agrotekhnicheskie meropriyatiya v bor'be s rzhavchinoi pshenitsy (Agricultural Procedures in the Control of Wheat Rusts). — In book: "Rzhavchina zernovykh kul'tur," Raboty I Vsesoyuznoi konferentsii po bor'be s rzhavchinoi zernovykh kul'tur, pp. 226 — 236, VASKHNIL. (1938) 1939.

Pronicheva, L. L. Rzhavchina zernovykh kul'tur (Rusts of Grain Crops). Moskva. 1945. 31 p.

Pronicheva, L. L. Rzhavchina lyutserny i molochaya v Rostovskoi oblasti (Rusts of Alfalfa and Spurge in the Rostov Region). — Selektsiya i Semenovodstvo, 3 (185) : 57 — 60. 1949a.

Observations carried out on alfalfa rust and the distribution of spurge.

Pronicheva, L. L. Listovaya rzhavchina zhitnyaka (Leaf Rust of Wheat Grass). — Selektsiya i Semenovodstvo, No. 6 : 55 — 57. 1949b.

Results of observations on the incidence of rust (**Puccinia persistens** Plowr.) on wheat grass. In infection experiments the fungus infected wheat grass and, to a lesser degree, rye; other experimental plants (wheat and **Agropyrum repens**) were not infected.

Pronicheva, L. L. Vliyanie vnekornevoi podkormki na snizhenie porazhennosti selektsionnykh sortov ozimoi pshenitsy buroi rzhavchinoi (The Effect of Leaf-Feeding on the Reduction of the Incidence of Brown Rust among Selected Varieties of Wheat). — In book: "Vnekornevaya podkormka sel'skokhozyaistvennykh rastenii," pp. 242 — 248, Moskva, Sel'khozgiz. 1955.

Protsenko, E.P. O parazitnom gribe na **Mahonia aquilfolium** Nutt. (Parasitic Fungi on **Mahonia aquilfolium** Nutt). — Byulleten' Glavnogo Botanicheskogo Sada AN SSSR, Vol. 6 : 50—53. 1950.

Cumminsiella sanguinea (Peck) Arth. is reported from the Main Botanical Gardens of Moscow. Data on the distribution of the fungus and its biology are given (according to the observations of T. Savulescu) in Figures II and III.

Protsenko, E.P. O patogennoi mikroflore Glavnogo botanicheskogo sada (Pathogenic Mycoflora of the Main Botanical Gardens). — Trudy Glavnogo Botanicheskogo Sada, Vol. 4 : 183—204. 1954.

Cumminsiella (Uropyxis) sanguinea Arth. is reported on **Mahonia, Melampsoridium betulae** (Schum.) Arth. on **Betula**, etc.

Pudovkin, A. M. Rzhavchiny khlebov i bor'ba s nimi (Rusts of Cereals and their Control). Simferopol . 1947. 42 p.

Pustovoit, G. V. Biotipy buroi rzhavchiny v Krasnodarskom krae (Biotypes of Brown Rusts in Krasnodar Territory). — Nauchnye otchety Krasnodarskoi Gosudarstvennoi selektsionnoi stantsii za 1937—1948 gg., Vol. 1 : 343—352. 1949.

Expermients were carried out with races 13, 20, 65, and 66 of **Puccinia triticina**.

Pustovoit, G. V. K voprosu o metodike ucheta rzhavchiny podsolnechnika (Methods of Evaluating Sunflower Rusts). — In book: "Kratkii otchet o nauchno-issledovatel'skoi rabote Vsesoyuznogo Nauchno-issledovatel'skogo instituta maslichnykh i efiromaslichnykh kul'tur za 1954 g.," pp. 25—29, Krasnodar. 1955.

Pustovoit, G. V. and V. V. Kosinskii. Vliyanie predshestvennikov na porazhaemost' ozimoi pshenitsy buroi rzhavchinoi (Influence of the Precursor on the Infectibility of Winter Wheat with Brown Rust). — In book: "Kratkii otchet Krasnodarskoi Gosudarstvennoi selektsionnoi stantsii o nauchno-issledovatel'skoi rabote za 1953 g.," pp. 43—49, Krasnodar. 1954.

Radzievskii, G. G. Gribnye bolezni drevesnykh i kustarnikovykh porod lesonasazhdenii Izmailovskoi oblasti (Fungal Diseases of Tree and Shrub Species of Forest Stands in the Izmail Region). — Botanicheskii Zhurnal URSR, 9 (3) : 66—71. 1952.

The report includes rust fungi detected on trees and shrubs. Bibliography contains 6 references.

Raevs'ka, I. O. and K. M. Komarets'ka. Do vyvchennya mikoflory Kanivs'koho biogeografichnoho zapovidnyka (A Study of the Mycoflora of the Kanev Biogeographical Forest Reserve). — Trudy Kanivs'k. bioheohraf. zapovidn., No. 7: 51 —62. 1949. [In Ukrainian.]

The catalogue lists 175 species of fungi: Uredinales, 59 species. Bibliography contains 15 references.

Raikova, I. A. Sornye rasteniya, vrediteli i bolezni rastenii na polyakh vostochnogo Pamira i ikh proiskhozhdenie (Weeds, Pests and Diseases of Plants and their Origin in the Fields of Eastern Pamir). — Trudy Sredneaziatskogo Gosudarstvennogo Universiteta, Novaya Seriya, Vol. 41, Biologicheskie Nauki, Vol. 14 : 79. 1953.

Rust fungi reported.

Rashevskaya, V. F. Obnaruzhenie efsidiev Melampsora lini Desm. v predelakh RSFSR (Detection of Aecia of **Melampsora lini** Desm. within the RSFSR). — Zashchita Rastenii ot Vreditelei, 5 (1) : 107. 1928.

On June 28, 29 and 30 and on July 1 aecia and spermogonia were found in the experimental station at Yasnaya Polyana (Gorodetskii District in Novgorod Province); aecia on the underside of the leaves (before blossoming of the flax) and spermagonia on both sides of the leaves. There is no description of 0 and I.

Rashevskaya, V. F. Fiziologicheskaya spetsializatsiya ras **Puccinia triticina** Erickss. i **P. dispersa** Erickss. et Henn. (Physiological Specialization of Races of **Puccinia triticina** Erickss. and **P. dispersa** Erickss. et Henn.). — Kratkie itogi rabot VIZR po rzhavchine khlebnykh zlakov za 1936 g., pp. 14—16, Izd. VIZR. 1937.

Infection experiments were carried out with races (20) of **Puccinia triticina** on several plants, including species of Genus **Aegilops**, **Bromus** and **Agropyrum**. The attempt to infect these grasses with races (1) of **Puccinia dispersa** was not successful.

Rashevskaya, V. F. Kharakter spetsializatsii ras rzhavchiny i puti razresheniya etogo voprosa (Specialization of Rust Races and Means of Solving this Problem). — In book: "Rzhavchina zernovykh kul'tur," Raboty I Vsesoyuznoi konferentsii po bor'be s rzhavchinoi zernovykh kul'tur, pp. 170—180, VASKHNIL. (1938) 1939.

Rashevskaya, V. F. and A. S. Barmenkov. Vyyavlenie rasovogo sostava buroi listovoi rzhavchiny pshenitsy **Puccinia triticina** (Development of Racial Composition of Brown Leaf Rust of Wheat, **Puccinia triticina**). — Itogi nauchno-issledovatel'skikh rabot VIZR za 1935 g., pp. 485—487. 1936a.

Rashevskaya, V. F. and A. S. Barmenko. Vyyavlenie fiziologicheskikh ras **Puccinia triticina** Erickss. v Soyuze v 1935 godu (Development of Physiological Races of **Puccinia triticina** Erickss. in the Soviet Union in 1935). — Zashchita Rastenii, 10 : 5—20. 1936b.

Rashevskaya, V.F. and V.P. Nilova. Vliyanie aktivnosti katalazy na ustoichivost' pshenitsy pri porazhenii buroi rzhavchinoi (Effect of Catalase Activity on the Resistance of Wheat Attacked by Brown Rust). — Izv. AN SSSR, Seriya Biologii, No. 4: 63—67. 1952.

Catalase activity is enhanced in the tissues of the host attacked by **Puccinia triticina**. The author maintains that increased catalase activity in the leaves elevates susceptibility (p. 67).

Rastegaeva, E.M. Vnekornevaya podkormka kak mera bor'by s buroi rzhavchinoi pshenitsy (Leaf-Feeding in the Control of Brown Rust of Wheat). — Zemledelie, No. 3: 114. 1955.

Regel', R.K. K voprosu ob otnoshenii razlichnykh ras yachmenya k porazheniyu rzhavchinoyu pri raznykh usloviyakh (Behavior of Different Barley Races to Rust Affections in Various Conditions). — Trudy Byuro po Prikladnoi Botanike, 3(8): 314—316. 1910.

Reikhardt, E.I. K mikoflore Petrogradskoi gubernii (Mycoflora of Petrograd Province). — Izvestiya Sevastopol'skoi Oblastnoi Stantsii Zashchity Rastenii ot Vreditelei, Vol. 5: 35—51, Leningrad. 1925.

More than 40 species of rusts are reported.

Renard, K.T. Sluchai immunnosti nekotorykh chistykh linii l'na k porazheniyu l'nyanoi rzhavchinoi (The Immunity of Some Pure Lines of Flax to Infection by Flax Rusts). — Zapadno-Belorusskaya Sel'-skokhozyaistvennaya Akademiya, Vol. 4: 77. 1927.

Rodigin, M.N. Redkie i maloizvestnye gribnye bolezni saflora v Povolzh'e (Rare and Little-Known Fungal Diseases of Safflower in the Volga Region). — Trudy Saratovskogo Sel'skokhozyaistvennogo Instituta, 1(6): 186—190. 1939.

The author describes aecidia on safflower: "Pycnidia are buried in the tissue of the upper side of the leaves. Aecidia hypophyllous, gathered in heaps on round patches, 2—6 mm in diameter. Aecidiospores gold-yellow or orange-colored, rounded, measuring 15×20 microns" (p. 187). The author assumes that the aecidia found belong to **P. carthami** (H.) Cda.

Romashchenkov, D.D. Ustoichivost' yarovoi pshenitsy k buroi listovoi rzhavchine v zavisimosti ot kolichestva pervichnykh zarodyshevykh kornei i energii kushcheniya (The Resistance of Summer Wheat to Brown-Leaf Rust Correlated to the Number of the Primary Embryonic Roots and the Intensity of Tillering). — Sbornik Rabot Instituta Prikladnoi Zoologii i Fitopatologii, Vol. 1: 92—160. 1951.

"With the increasing intensity of tillering, rust infectibility of the leaves of the primary stems drops or is completely absent; rust infectibility of leaves of secondary growth is also lower" (p. 99). The tillering intensity is in turn connected with the absolute weight of the seed and soil moisture.

R o m a s h c h e n k o v, D. D. O nekotorykh osobennostyakh biologii kushcheniya yarovykh pshenits i ikh ustoichivosti k steblevoi rzhavchine (Certain Characteristics of the Biology of Tillering in Summer Wheat and Resistance to Stem Rust). — Ibid., Vol. 2 : 75 — 84. 1953.

R o s t o v t s e v, S. Otchet ad'yunkt-professora Rostovtseva (Report of Asst. Professor Rostovtsev). — Izvestiya Moskovskogo Sel'skokhozyaistvennogo Instituta, Otdel Offitsial'nyi, 2(4): 19 — 23. 1896a.

Rust fungi found in Moscow Province, in the vicinity of Petrovskoe-Razumovskoe, are reported on pp. 21 — 22.

R o s t o v t s e v, S. Posobie k opredeleniyu paraziticheskikh gribov po rasteniyami khozyevam (Aid to Determination of Parasitic Fungi According to Plant Hosts). — Ibid., p. 41. 1896b.

Lists rust fungi according to plant hosts.

R o s t o v t s e v, S. Spisok paraziticheskikh gribov iz okrestnostei g. Tobol'ska (List of Parasitic Fungi from the Environs of Tobol'sk). — Ibid., 4(2): 71 — 75. 1898.

Forty-seven species of rust fungi are listed; some are not accurately identified.

R o t e r s, B. V. K mikologicheskoi flore S.-Dvinskoi gubernii (The Mycoflora of the Northern Dvina Province). — Zapiski Severo-Dvinskogo Obshchestva po Izucheniyu Mestnogo Kraya, gor. Velikii Ustyug, Vol. 4 : 68 — 83. 1927a.

R o t e r s, B. V. Ocherk boleznei rastenii v Sochinskom okruge (Plant Diseases in the Sochi District). — Zashchita Rastenii ot Vreditelei, 4(6): 962 — 967. 1927b.

Rust fungi are reported.

R o z a n o v, S. M. Bolezni rastenii, prichinyaemye rastitel'nymi parazitami (Plant Diseases Caused by Parasites). — Russkoe Sel'skoe Khozyaistvo, Vol. 5 : 30 — 71. 1870. Vol. 6 : 61 — 81. 1870. Ibid., Moskva. 1871. Preprint.

Some 30 species of rust fungi are reported.

R u s a k o v, L. F. Vliyanie meteorologicheskikh elementov na razvitie rzhavchinnykh gribov (Effect of Meteorological Elements on the Development of Rust Fungi). — Materialy po Mikologii i Fitopatologii Rossii, 4(1): 32 — 49. 1922a.

R u s a k o v, L. F. Nablyudeniya nad razvitiem rzhavchiny na kul'turnykh zlakakh v Kamennoi stepi v 1919 godu (Observations on the Development of Rust on Cultivated Cereals in Kamennaya Steppe in 1919). — Ibid., 4(1): 77 — 87. 1922b.

Rusakov, L. F. K vesennemu prorastaniyu teleitospor (The Germination of Teliospores in Spring). — Zashchita Rastenii ot Vreditelei, 1(3—5): 146—148. 1924a.

Rusakov, L. F. **Puccinia coronifera** Kleb. na **Rhamnus** cathartica v Kamennoi stepi v 1921 g. (**Puccinia coronifera** Kleb. on **Rhamnus cathartica** in Kamennaya Steppe in 1921). — Ibid., 1(6): 226—228. 1924b.

Rusakov, L. F. Osobennosti mikroklimata zony rastenii i razvitie rzhavchiny khlebov (Characteristics of the Microclimate of Plant Zones and the Development of Grain Rusts). — Trudy IV Vserossiiskogo entomo-fitopatologicheskogo s''ezda 1922 g., pp. 201—216, Leningrad. 1924c.

Rusakov, L. F. Iz rezul'tatov po issledovaniyu rzhavchiny khlebov s 1922—24 gg. (Results of Grain Rust Research 1922—1924). — Zashchita Rastenii ot Vreditelei, 2(7): 569—571. 1925a.

Rusakov, L. F. K voprosu ob uchete vreda ot rzhavchiny khlebov (An Evaluation of Damage Caused by Grain Rusts). — Ibid., 2(7): 577—580. 1925b.

Rusakov, L. F. Iz nablyudenii po biologii rzhavchinykh khlebov (Tezisy doklada) (Studies on the Biology of Grain Rusts (Synopses of Reports)). — Izvestiya Gosudarstvennogo Instituta Opytnoi Agronomii, 3(2—3): 150—151. 1925c.

Rusakov, F. L. Massovoe porazhenie ozimoi rzhi **Puccinia coronifera** Kleb. osen'yu 1924 g. (Outbreak of **Puccinia coronifera** Kleb on Winter Rye in the Fall of 1924). — Bolezni Rastenii, 14(1): 7—11. 1925d.

Rusakov, L. F. Iz issledovanii po rzhavchine khlebov v Amurskoi gub. v 1925 g. (Studies of Grain Rusts in Amur Province in 1925). — Ibid., 14(4): 128—136. 1925e.

Rusakov, L. F. Rzhavchina pshenitsy v Amurskoi gub. v 1923 godu (Wheat Rust in Amur Province in 1923). — Izvestiya Amurskoi Oblastnoi Sel'skokhozyaistvennoi Opytnoi Stantsii, 2(8—9): 130—136, Blagoveshchensk. 1925f.

Rusakov, L. F. Izuchenie rzhavchiny khlebov v Amurskoi oblasti v 1925 g. (Study of Grain Rusts in the Amur Region in 1925). — Ibid., 2(10—12): 164—175, Blagoveshchensk. 1925g.

Rusakov, L. F. K voprosu o perezimovke rzhavchiny khlebov (The Overwintering of Grain Rusts). — Materialy po Mikologii i Fitopatologii, 5(1): 17—32. 1926a.

Rusakov, L. F. Vesennee prorastanie teleitospor (Germination of Teliospores in Spring). — Ibid., 5(2): 76—92. 1926b.

Rusakov, L. F. Letnyaya kartina razvitiya rzhavchiny (Rust Development in the Summer). Summary of Report. — Izvestiya Gosudarstvennogo Instituta Opytnoi Agronomii, 4(1—2): 86. 1926c.

Rusakov, L. F. O nablyudeniyakh nad rzhavchinoi na Dal'nem Vostoke letom 1925 g. (Observations on Rusts of the Far East in Summer 1925) Summary of Report. — Ibid., 4(1—2): 87—88. 1926d.

Rusakov, L. F. Programma izucheniya vliyaniya sredy na rzhavchinu khlebov (A Plan for the Study of the Effect of the Medium on Grain Rusts). — Zashchita Rastenii ot Vreditelei, 2(7): 571—573. 1926e.

Rusakov, L. F. Rzhavchina khlebov v Dal'nevostochnoi oblasti po dannym obsledovaniya 1925 g. i mery bor'by s neyu. (Grain Rusts and their Control in the Far-Eastern Region according to Data Recorded in 1925) Synopses of Report. — Pervaya konferentsiya po izucheniyu proizvoditel'nykh sil Dal'nego Vostoka, pp. 43—45, Khabarovsk. 1926f.

Rusakov, L. F. Kombinirovannaya shkala dlya ucheta razvitiya rzhavchiny (A Composite Scale for the Calculation of Rust Development). — Bolezni Rastenii, 16(2): 179—185. 1927a. With 1 table.

Rusakov, L. F. Obsledovanie krest'yanskikh pshenits yuzhnogo Primor'ya na porazhennost' ikh steblevoi rzhavchinoi v 1925 g. (Examination of Stem Rust Infection in Wheat Farms in Southern Maritime Territory in 1926). — Izvestiya Primorskoi Opytnoi Stantsii, Vols. 3—6: 97—111. 1926. See also: Izvestiya Gosudarstvennogo Instituta Opytnoi Agronomii, 5(2—3): 202—203. 1927b.

Rusakov, L. F. Rzhavchina khlebov v Dal'ne-Vostochnom krae po dannym ankety za 1925 god (Grain Rusts in the Far-Eastern Territory According to Data Based on a Survey in 1925). — Materialy po Mikologii i Fitopatologii, 6(1): 96—122. 1927c.

A comprehensive survey of the distribution and the harmfulness of grain rusts. The most injurious proved to be stem rust. According to the author "the damage inflicted by rusts at times reached such proportions that the grain consisted of empty husks and the dry straw burned up or remained on the roots" (p. 121).

Rusakov, L. F. Rzhavchina khlebov na Dal'nem Vostoke (Grain Rusts in the Far East). — Dal'novostochnoe Zemel'noe Upravlenie Amurskoi Oblastnoi Sel'skokhozyaistvennoi Opytnoi Stantsii, Blagoveshchensk. 1927d. 35 p. With 5 illustrations.

Rusakov, L. F. Pamyatnaya knizhka po rzhavchine khlebnykh zlakov (Memorandum on Cereal Rusts). — Izdanie Mikologicheskoi i Fitopatologicheskoi Laboratorii im. Prof. A. A. Yachevskogo, Leningrad. 1928a. 7 p. + additional pages for notes on summer inspection of grain rusts.

Rusakov, L. F. Porazhenie 1,290 chistykh linii pshenits (st. rzhavchinoi) i ponyatie ob immunitete vo vremeni (Infection of 1,290 Pure Lines of Wheat (by Rusts) and the Concept of Immunity in Time). — Dnevnik Vsesoyuznogo s"ezda botanikov v Leningrade v yanvare 1928 g., pp. 183—184. 1928b.

Rusakov, L. F. Opyt gruppirovki ozimykh pshenits po porazheniyu ikh buroi rzhavchinoi (Experimental Grouping of Winter Wheat According to their Infection with Brown Rust). — Bolezni Rastenii, 18(1—2): 54—65. 1929.

Rusakov, L. F. Rzhavchina khlebov na Rostovo-Nakhichevanskoi sel'skokhozyaistvennoi opytnoi stantsii v 1927 godu (Grain Rusts in the Agricultural Experimental Station of Rostov-Nakhichevan in 1927). — Izvestiya po Opytnomu Delu Severo-Kavkaza, No. 15—16: 213—236, Rostov-na-Donu. 1929a.

Rusakov, L. F. Rzhavchina khlebov na Eiskoi sel'skokhozyaistvennoi opytnoi stantsii v 1927 g. (Grain Rusts in the Eisk Agricultural Experimental Station in 1927). — Zashchita Rastenii ot Vreditelei, 6(1—2): 103—127. 1929b.

Rusakov, L. F. Kharakteristika selektsionnykh sortov yachmenya, pshenitsy i ovsa na stoikost' ikh k razlichnym vidam rzhavchiny (Characteristics of Varieties of Barley, Wheat and Oats Selected According to their Resistance to Different Species of Rusts). — Izd. Stavropol'-Kavkazskoi Sel'skokhozyaistvennoi Opytnoi Stantsii, Stavropol'. 1929c. 14 p.

Rusakov, L. F. Metodika ucheta rzhavchiny khlebov i ee vredonosnosti v sortoispytanii (Methods of Evaluating Grain Rusts and their Damage in Variety Analysis). — Trudy Vsesoyuznogo s"ezda po genetike, selektsii, semenovodstvu i plemennomu zhivotnovodstvu v Leningrade 10—16 yanvare 1929 g. V. Semenovodstvo i sortoizuchenie, pp. 135—145. 1930a.

Rusakov, L. F. Opylivanie pshenichnykh posevov sernym tsvetom, kak bor'by s rzhavchinoi khlebov (Wheat Sowings Dusted with Flower of Sulfur as a Control Measure against Rusts). — Izvestiya po Opytnomu Delu Severo-Kavkaza, 3(20): 1—7, Rostov-na-Donu. 1930b.

Rusakov, L. F. Osobennosti epidemii rzhavchiny khlebov v raione Primorskoi oblastnoi sel'skokhozyaistvennoi opytnoi stantsii v 1926 g. (Characteristics of the Grain-Rust Epidemic in Area of the Maritime

Territory Regional Experimental Agricultural Station in 1926). — Zashchita Rastenii ot Vreditelei, 6(5—6): 695—718. 1930c.

Rusakov, L. F. K postroeniyu sistemy meropriyatii po bor'be s rzhavchinoi khlebov (The Construction of a System to Control Grain Rusts). Synopses of Report. — Byulleten' VII Vsesoyuznogo s"ezda po zashchite rastenii, No. 6 : 14, Leningrad. 1932a.

Rusakov, L. F. Vredonosnost' rzhavchiny po dannym vegetatsionnogo i polevogo opytov (The Harmfulness of Rusts from Data of Vegetation and Field Experiments). Synopses of Report. — Ibid., No. 6 : 15—16, Leningrad. 1932b.

Rusakov, L. F. Osnovy metodiki selektsii na ustoichivost' k rzhavchine i itogi rabot (Principles of Selection Methods on Resistance to Rusts and Ensuing Results). Synopses of Report. — Ibid., No. 8 : 20—21, Leningrad. 1932c.

Rusakov, L. F. Otnositel'naya porazhaemost' rzhavchinoi razlichnykh sortov ozimoi i yarovoi pshenitsy (Relative Susceptibility to Rusts of Different Varieties of Summer and Winter Wheat). — Sorta zernovykh kul'tur i raiony ikh rasprostraneniya, Vol. 1 : 465—476, Leningrad. 1932d.

Rusakov, L. F. Rzhavchina khlebov (Grain Rusts). Synopsis of Report. — Sbornik VIZR, No. 4 : 55—57, Leningrad. 1932e.

Rusakov, L. F. Rzhavchina khlebov (Grain Rusts). — Metodika sortoispytaniya glavneishikh sel'skokhozyaistvennykh kul'tur, Vol. 2 : 112—118, Leningrad. 1932f.

Rusakov, L. F. Unichtozhim barbaris i slabitel'nuyu krushiny — peredatchikov rzhavchiny na polya (Eradication of Berberis and Common Buckthorn — Carriers of Rusts into Fields). — Na Zashchitu Sotsialisticheskogo Urozhaya, Nos. 11—12 : 24—26, Moskva. 1932g.

Rusakov, L. F. Ustoichivost' sortov khlebnykh zlakov k rzhavchine i golovne (Resistance of Cereal Varieties to Rusts and Smuts). — Gossortoset', Vol. 2 : 24—36, Leningrad. 1932h.

Rusakov, L. F. Rzhavchina khlebov i mery bor'by s nei (Grain Rusts and their Control). — Na Zashchitu Urozhaya, No. 3 : 29—31, Moskva. 1933a.

Rusakov, L. F. Selektsiya v bor'be s rzhavchinoi khlebov (Selection of Control Measures against Grain Rusts). — Ibid., No. 10 : 17—21. 1933b.

Rusakov, L. F. Kanred X Ful'kaster 266287 i drugie amerikanskie sorta pshenitsy, ustoichivye k buroi rzhavchine (Canred X Fulcaster 266287 and Other American Varieties of Wheat Resistant to Brown Rust). — Trudy po Prikladnoi Botanike i Selektsii, Seriya A21, pp. 31—42. 1937.

Rusakov, L. F. Rzhavchina khlebov i problema sortosmeny (Grain Rusts and the Question of Strain Shifts). — In book: "Rzhavchina zernovykh kul'tur," Raboty I Vsesoyuznoi konferentsii po bor'be s rzhavchinoi zernovykh kul'tur, pp. 111—140, VASKHNIL. (1938) 1939.

Rusakov, L. F. and M. F. Panchenko. Porazhenie 1,290 chistykh linii pshenits steblevoi rzhavchinoi i ponyatie ob immunitete vo vremeni (Infection of 1,290 Pure Lines of Wheat with Stem Rust and the Concept of Immunity in Time). — Izvestiya Primorskoi Oblastnoi Sel-skokhozyaistvennoi Opytnoi Stantsii, Vol. 10 : 179—195. 1928.

Rusakov, L. F. and A. Pokrovskii. Buraya rzhavchina na yarovykh pshenitsakh Omskogo uchastka sortoispytaniya VIPB i NK v 1928 g. (Brown Rust on Summer Wheats of the Omsk Sector of Strain Testing sis, of the All-Union Institute of Applied Botany and New Cultures, in 1928). — Materialy po Mikologii i Fitopatologii, 7 (1) : 240—272. 1928.

Rusakov, L. F. and L. L. Pronicheva. Rzhavchina khlebov v Azovo-Chernomorskom krae v 1936 godu (Grain Rusts in the Azov-Black Sea Territory in 1936). — Kratkie itogi rabot VIZR po rzhavchine khlebnykh zlakov za 1936, pp. 47—49, Izd. VIZR. 1937.

Report drawn up by V. P. Teilinskaya.

Rusakov, L. F. and A. A. Shitikova. Zimovka rzhavchiny na ozimykh v D.-V. krae po dannym za 1926 g. (Overwintering of Rusts on Winter Crops in the Far Eastern Territory according to 1926 Data). — Izvestiya Primorskoi Oblastnoi Sel'skokhozyaistvennoi Opytnoi Stantsii, Vol. 10 : 196—218. 1928.

Rusakov, L. F. and A. A. Shitikova. Rzhavchina khlebov v Severo-Kavkazskom krae (Grain Rusts in the North Caucasus Territory). — Izvestiya po Opytnomu Delu Severo-Kavkaza, Nos. 13—14 : 17—47. 1929.

Rusakov, L. F. and A. A. Shitikova. Rzhavchina khlebov na Zapadno-Sibirskom (Omskoi) oblastnoi sel'skokhozyaistvennoi opytnoi stantsii v 1928 godu (Grain Rusts in the West Siberian (Omsk) Regional Experimental Agricultural Station in 1928). — Materialy po mikologii i Fitopatologii, 8 (1) : 104—202. 1929. With 44 tables.

The study covers the overwintering and dvelopment of rust fungi, the effect of forest borders and strip fallow, and the effect of intermediate hosts, harmfulness, variety resistance, etc. The general conclusion is of interest: the local variety is most severely attacked. Bibliography contains 13 references.

R u s a k o v a, A. A. Buraya rzhavchina na kakhetinskoi vetvistoi pshenitse (Brown Rust on Branchy-Eared Wheat). — Agrobiologiya, No. 3 : 180—182. 1949.

Observations of the development of rust at the VASKHNIL experimental base in Gorki Leninskie; the preparation "colloid sulfur" was tested as a means of rust control.

R u z i n o v, P. G. Issledovanie vredonosnosti nekotorykh boleznei khlebnykh zlakov v polevykh usloviyakh (Study of the Harmfulness of Some Cereal Diseases in Field Conditions). — Trudy po Zashchite Rastenii, Seriya 2, Vol. 4 : 1—30. 1934.

Damage caused by **Puccinia triticina** and **P. coronifera** is described.

R y a k h o v s k i i, N. A. Novye dlya Voronezhskoi oblasti vidy parazitnykh gribov (New Species of Parasitic Fungi in the Voronezh Region). — Botanicheskii Zhurnal SSSR, 20 (5) : 473. 1935.

Puccinia pimpinella (Str.) Mart. on **Pimpinella anisum** L.

R y t o v, M. V. Bolezni i povrezhdeniya ogorodnykh rastenii (Diseases and Injuries of Vegetables). Moskva. 1923. 185 p. Illustrated.

S a b u r o v a, P. V. Fiziolocheskoe obosnovanie porazhaemosti pshenitsy buroi rzhavchinoi (**Puccinia triticina**) pod vliyaniem razlichnoi vlazhnosti pochv (Physiological Basis of Wheat Susceptibility to Brown Rust (**Puccinia triticina**) under the Effect of Different Soil Moistures). — Botanicheskii Zhurnal SSSR, 31 (4) : 35—48. 1946.

S a r k i s y a n, S. S. Materialy po boleznyam dekorativnykh tsvetochnykh kul'tur Armyanskoi SSR (Data on Diseases of Ornamental Flowering Crops in the Armenian SSR). — Nauchnye Trudy Erevanskogo Gosudarstvennogo Universiteta, Vol. 38 : 139—159. 1953.

Rust fungi are reported.

S a v z d a r g, E. E. and A. A. T r o f i m o v i c h. Zashchita urozhaya ot vreditelei i boleznei (Protection of the Harvest from Pests and Diseases). — Moskva, Izd. TsK VKLSM. 1950. 71 p.

Rusts of cereals and flax are reported.

S a z o n o v, P. V. Opyt primeneniya aviäopryskivaniya suspenziei kolloidnoi sery posevov pshenitsy dlya zashchity ikh ot porazheniya buroi rzhavchinoi (Experimental Aircraft Spraying of Wheat Sowings with a Colloidal Sulfur Suspension to Prevent Brown Rust). — Trudy VIZR, Vol. 3 : 98—103. 1951.

Selektsiya zernovykh kul'tur na ustoichivost' k boleznyam (Selection of Grain Crops according to Resistance to Diseases). — Khar'kovskaya Gosudarstvennaya Selektsionnaya Stantsiya Ministerstva Sel'skogo Khozyaistva SSSR. Raboty po selektsii i semenovodstvu, pp. 268—279, Kiev-Kharkov. 1947.

Methods and some research results on resistance of cereals to rust fungi.

S e m a s h k o, V. Materialy k mikologicheskoi flore Rossii. Spisok gribov sobrannykh L. Garbovskim v okrestnostyakh Smely Kievskoi gubernii letom i osen'yu 1912 goda (List of Fungi Collected by L. Garbovskii in the Environs of Smela, Kiev Province, in the Summer and Fall of 1912). — Trudy Byuro po Prikladnoi Botanike, 6(11): 710—719. 1913. With 7 illustrations.

Puccinia taraxaci is reported.

S e m a s h k o, V. Materialy k mikologicheskoi flore Sukhumskogo okruga (Material for the Mycoflora of the Sukhumi District). — Materialy po Mikologii i Fitopatologii Rossii, 1(3): 23—41. 1915. With 16 plates. Errata. — Ibid., 3(1): 85. 1917.

Of the 216 fungal species, 42 are rusts; 12 species of rust fungi are mentioned in the Errata.

S e m a s h k o, V. Ocherk boleznei rastenii v Abkhazii (Survey of Plant Diseases in Abkhaziya). — Trudy II Vserossiiskogo entomo-fitopatologicheskogo s"ezda 1920 g., pp. 152—168, Petrograd. 1921.

Rust fungi reported.

S e r b i n o v, I. L. K voprosu o glavneishikh boleznyakh i vreditelyakh Astrakhanskogo i Kamyshinskogo kraya (The Main Pests and Diseases of the Astrakhan and Kamyshin Territories). — Bolezni Rastenii, 8(6): 155—174. 1914.

Twenty-nine species of fungal species, among them **Phragmidium subcorticium**, are listed on pp. 163—165.

S e r b i n o v, I. L. Bolezni sel'skokhozyaistvennykh rastenii (Diseases of Agricultural Plants). Odessa. 1922. 116 p.

S e r e b r y a n n i k o v, I. Materialy k poznaniyu flory Moskovskoi gubernii (Contribution to the Study of the Flora of Moscow Province). — Izvestiya Moskovskogo Sel'skokhozyaistvennogo Instituta, 3(4): 101—113. 1897.

The report includes 73 species of rust fungi and indicates the spor forms, plant hosts and site of collection.

S e r g e e v a, K. S. K voprosu o prorashchivanii spor gribov (Germination of Fungal Spores). — Priroda, Nos. 7—8: 97—99. 1942.

Experimental germination of spores of **Uromyces nerviphilus** on **Trifolium repens** and other plants.

S e r g e e v a, K. S. O sposobakh perezimovki rzhavchiny **Uromyces fallens** (Desm.) Kern (Overwintering of the Rust **Uromyces fallens** (Desm.) Kern). — Priroda, No. 4: 51. 1948.

Sergeeva, K. S. Rzhavchina klevera i lyutserny (Rusts of Clover and Alfalfa). — Trudy Botanicheskogo Instituta AN SSSR, Seriya II, Sporovye Rasteniya, Vol. 8 : 109 — 178. 1953.

Studies on clover and alfalfa rusts: detailed diagnoses with illustrations of the species.

Shafranskaya, V. N. Sosnovyi vertun v pitomnikakh i bor'ba s nim (Pine-Twisting Rust and its Control in Nurseries). — In book: "Bolezni sosny i duba i bor'ba s nimi v pitomnikakh i kul'turakh," by A. M. Ankudinov et al. — Sbornik Rabot Vsesoyuznogo Nauchno-Issledovatel'skogo Instituta Lesnogo Khozyaistva, pp. 101 — 118, Moskva-Leningrad. 1951.

Observations of the germination of teliospores of **Melampsora pinitorqua** in the course of infection, incubation period, etc. are recorded. The viability of basidiospores in increased humidity is retained, according to the author, up to 30 hours, and the incubation period of the aecidial stage 9 — 14 days. Bibliography contains 12 references. Other works of the author are noted.

Shcherbak, S. Selektsiya podsolnechnika na ustoichivost' k rzhavchine (Selection of Sunflower by Resistance to Rust). — Trudy po Prikladnoi Botanike i Selektsii, Seriya A, No. 21 : 67 — 76. 1937. With 2 charts.

Shcherbin-Parfenenko, A. L. Bolezni bereskleta evropeiskogo i ikh vozbuditeli (Spindle-Tree Diseases and their Agencies). — In book: "Nauchno-tekhnicheskii sbornik trudov po lesnomu khozyaistvu Severnogo Kavkaza," Vol. 1 : 169 — 197, Maikop. 1954. (Severno-Kavkazskaya Lesnaya Opytnaya Stantsiya Vsesoyuznogo Nauchno-Issledovatel'skogo Instituta Lesnogo Khozyaistva).

Shell', Yu. Materialy dlya botanicheskoi geografii Ufimskoi i Orenburgskoi gubernii. Sporovye rasteniya (Material for the Phytogeography of Ufa and Orenburg Provinces. Sporophytes). — Trudy Obshchestva Estestvoispytatelei pri Imperatorskom Kazanskom Universitete, 12 (1) : 1 — 93. 1883.

The list includes 156 species of fungi. For rust fungi, see Thümen, 1880a, 1880b.

Shembel', S. Yu. Materialy k mikologicheskoi flore Minskoi gub. (Material for the Mycoflora of Minsk Province). — Trudy Byuro po Prikladnoi Botanike, 6 (11) : 697 — 709, 719. 1913. With 2 plates and 1 photograph.

Fifteen species of rust fungi (Nos. 26 — 40).

Shembel', S. Yu. Materialy k mikologicheskoi flore Astrakhanskoi gub. (Material for the Mycoflora of Astrakhan Province). — Materialy po Mikologii i Fitopatologii Rossii, 1 (1) : 7 — 41. 1915a.

Thirty-two species of rust fungi (Nos. 39 — 70).

Shembel', S. Yu. Svedeniya o rasprostranenii gribnykh, bakterial'nykh i funktsional'nykh boleznei kul'turnykh i poleznykh dikorastushchikh rastenii v Astrakhanskoi gub. v 1914 godu. Otchet o deyatel'nosti Entomologicheskoi stantsii i Mikologicheskogo otdeleniya za 1914 god (Data on the Distribution of Fungal, Bacterial and Functonal Diseases of Crops and Useful Wild Plants in Astrakhan Province in 1914. Report on the Activities of the Entomological Station and Mycological Department for 1914). — Entomologicheskaya stantsiya Astrakhanskogo obshchestva sadovodstva, ogorodnichestva i polevodstva, pp. 50—52, Astrakhan. 1915b.

Several species of rust fungi are reported; observations on the harmfulness of rusts and the resistance of some grain varieties.

Shembel', S. Yu. Obzor boleznei rastenii Astrakhanskogo kraya, nablyudavshikhsya po 1923 god (Survey of Plant Diseases in the Astrakhan Territory Recorded in 1923). — Zapiski Astrakhanskoi Stantsii Zashchity Rastenii ot Vreditelei, 1 (1): 58. 1923.

Twenty-nine species of rust fungi reported.

Shembel', S. Yu. Novye vidy astrakhanskoi mikologicheskoi flory (New Species of Astrakhan Mycoflora). — Ibid., 1 (3): 1—11. 1924. (Preprint).

Description of **Uromyces alhaginis** S. Szemb. on **Alhabi camelorum** Fisch.; Russian and Latin diagnoses given.

Shembel', S. Yu. Mikologicheskie zametki. Novyi vid rzhavchiny na konople (Mycological Notes. New Species on Hemp). — Ibid., 1 (5—6): 59—60. 1927.

Aecidium cannabis S. Szemb. (sp. nov.) reported.

Shembel', S. Yu. Rasprostranenie glavneishikh boleznei kul'turnykh rastenii v Astrakhanskom okruge v 1926—1929 godakh (Distribution of the Main Diseases of Crops in the Astrakhan District in 1926—1929). Astrakhan. 1930. 20 p.

Four species of rust fungi reported.

Shevchenko, F. P. Rzhavchina na khlebakh i kak s nei borot'sya (Rusts on Cereals and Means of Combating Them). — Sovetskii Sakhar, No. 8: 21—23, Moskva-Leningrad. 1933.

Shevchenko, E. P. Povyshenie ustoichivosti k boleznyam u yarovykh kul'tur pri podzimnem poseve (Raising Resistance to Diseases of Summer Crops Sown in Late Fall). — Selektsiya i Semenovodstvo, No. 6: 53—54. 1950a.

The author maintains that sowing summer crops in the late fall raised the resistance of subsequent generations to brown and crown rusts.

Shevchenko, F.P. Povyshenie ustoichivosti sortov k boleznyam (Raising Varietal Resistance to Diseases). — Ibid., No. 8 : 35 — 38. 1950b.

The author recommends intervarietal selection and the practice of agricultural techniques in order to increase resistance of wheat to rust fungi.

Shevchenko, F.P. Nasledovanie ustoichivosti sortov yarovoi pshenitsy k boleznyam (Inheritance of Resistance to Disease by Summer Wheat Varieties). — Ibid., No. 4 : 7 — 11. 1951.

The author states that his experiments "confirmed the possibility of enhancing the resistance of sowing or breeding seeds of summer wheat by the intervarietal grafting method of transplanting the embryo to the endosperm of the variety resistant to the disease predominant in the region" (p. 11). Data on attacks by brown rust (and stem and yellow rust) of wheat subjected to graftings are included.

Shevchenko, F.P. Michurinskaya nauka v bor'be s boleznyami polevykh kul'tur (Michurin's Methods of Controlling Field Crop Diseases). — Altaikraiizdat. 1952. 28 p.

Data of interest in the development of control measures are presented.

Shishkina, A. K izucheniyu boleznei dekorativnykh rastenii Gruzii (Diseases of Ornamental Plants in the Georgian SSSR). — Ibid., Vol. 7 : 217 — 219. 1950.

Five species of rust fungi listed.

Shitikova, A.A. Ispytanie novykh preparatov VIZR v bor'be s buroi i steblevoi rzhavchinoi pshenitsy v 1936 g. (Experiments with New Preparations by VIZR for the Control of Brown — and Stem Rusts of Wheat in 1936). — Kratkie itogi rabot VIZR po rzhavchine khlebnykh zlakov sa 1936 g., pp. 9 — 11, Izd. VIZR. 1937a.

Shitikova, A.A. Razrabotka metodiki opredeleniya poter' ot rzhavchiny zernovykh zlakov (Elaboration of Methods for the Determination of Grain Losses Caused by Rust Fungi). — Ibid., pp. 36 — 41. 1937b.

Shitikova-Rusakova, A.A. Issledovanie vozdukha na soderzhanie v nem spor razlichnykh gribov (Air Analysis for the Content of Rust Spores). — Materialy po Mikologii i Fitopatologii, 5 (2) : 29 — 48. 1926.

Shitikova-Rusakova, A.A. Vopros o zanose rzhavchinnoi infektsii v Amurskuyu oblast' (The Problem of Transferring Rust Infections into the Amur Region). — Ibid., 6 (1) : 13 — 47. 1927. With 2 photographs and 7 tables.

An account of a thorough air analysis by means of an "aeroscope" for its content of aecidio- uredio- and teliospores.

Shitikova-Rusakova, A.A. Sravnenie osobennostei razvitiya rzhavchiny na Vostochnom i Zapadnom polyakh Stavropol'skoi sel'skokhozyaistvennoi opytnoi stantsii v 1927 g. (Comparative Study of the Character of Rust Development in the Eastern and Western Fields of the Stavropol Experimental Agricultural Station in 1927). — Ibid., 7(1):208—239. 1928.

Infection development dependent on ecological conditions; biological properties of several rust species.

Shitikova-Rusakova, A.A. Mikroflora vozdukha (Microflora of the Air). — Dnevnik Vsesoyuznogo s"ezda botanikov v Leningrade v yanvare 1928 goda, pp. 190—191, Leningrad. 1928.

Shitikova-Rusakova, A.A. Vliyanie vozdushnykh techenii na poyavlenie i razvitie rzhavchinnykh epidemii v razlichnykh raionakh Soyuza (The Effect of Air Currents on the Occurrence and Development of Rust Epidemics in Different Regions of the Soviet Union). — Zashchita Rastenii, 7(4—6):361—363. 1931.

Shitikova-Rusakova, A.A. Vliyanie peresadki rastenii ozimoi rzhi i pshenitsy na razvitie rzhavchiny (The Effect of Transplanting Winter Rye and Wheat Plants on the Development of Rusts). — Trudy po Zashchite Rastenii, 5(1):85—96. 1932a.

Shitikova-Rusakova, A.A. Osobennosti rasprostraneniya spor v vozdukhe glavnym obrazom spor rzhavchiny khlebov (Certain Patterns of Dissemination of Spores, Mainly Grain Rust Spores, in the Air). — Ibid., 5(1):131—140. 1932b. With 2 plates.

Shitikova-Rusakova, A.A. Vredonosnost' rzhavchiny khlebnykh zlakov (Harmfulness of Grain Rusts). — In book: "Rzhavchina zernovykh kul'tur," Raboty I Vsesoyuznoi konferentsii po bor'be s rzhavchinoi zernykh kul'tur," pp. 212—226, VASKHNIL. (1938) 1939.

Shmidt, V. V. Bolezni kendyrya i kenafa. Bolezni i vrediteli novykh lubyanykh kul'tur (Diseases of Indian Hemp and Ambary. Diseases and Pests of New Bast Culture). — Sbornik Izd. Instituta Novogo Lubyanogo Syr'ya, pp. 13—19, Moskva, VASKHNIL. 1933.

Melampsora apocyni Tranz. reported.

Shopina, V. V. Vliyanie predshestvennikov na izmenenie u sortov ozimoi pshenitsy porazhaemosti buroi rzhavchinoi v usloviyakh Krasnodarskogo Kraya (Influence of the Precursor on Variations of Winter Wheat Varieties Affected by Brown Rust in the Krasnodar Territory). Author's summary of thesis, Leningrad. 1955. 22 p.

Shoshiashvili, I.I. Rzhavchina khlebnykh zlakov i mery bor'by s nei (Cereal Rusts and their Control). — AN Gruz. SSR. Tbilisi. 1954. 40 p. Illustrated.

Shoshiashvili, I.I. and Sh.A. Dzatnidze. Materialy po izucheniyu porazhaemosti sortov pshenitsy rzhavchinoi v Gruzinskoi SSR (Material for the Study of Wheat Susceptibility to Rusts in the Georgian SSR). — Trudy Instituta Zashchity Rastenii AN Gruz. SSR, Vol. 10: 53—66. 1954.

Shtukenberg, E.K. Spisok gribov-vreditelei, khranyashchikhsya v muzee Penzenskogo obshchestva lyubitelei estestvoznaniya (List of Fungal Pests in the Museum of the Penza Naturalists Society), pp. 31—41, Penza. 1913. (Preprint).

Fifteen species of rust fungi from the former Penza and Saratov Provinces.

Shulyndin, A.F. Ozimaya pshenitsa, ustoichivaya k buroi rzhavchine, poluchennaya putem podzimnego poseva (Winter Wheat Resistant to Brown Rust Obtained by Late Fall Sowing). — Agrobiologiya, No. 4: 129—131. 1953.

The author maintains that "if the plant of the late fall sowing has overwintered in the stage of germinating seed and sprouts appear only in the spring, then in certain years new forms appear in the progeny and botanical variants are different from the initial variety in morphology and physiology" (pp. 129—130). This was observed by the author in 1950 in the varieties Lyutescens 17, Odesskaya 13, Zenitka and Ukrainka. Of special interest is the progeny of the variant Ferrugineum 510 (obtained from Lyutescens 17) which is distinguished by its high resistance to brown rust.

Shvartsman, S.R. Gribnye bolezni drevesnykh porod Kazakhstana i mery bor'by s nimi (Fungal Diseases of Tree Species in Kazakhstan and their Control). Alma-Ata. 1950. pp. 1—111.

The following rust fungi species are reported: **Coleosporium** — 2 species, **Melampsoridium betulae** Arth., **Melampsora** — 3 species, **Melampsorella cerastii** Wint., **Puccinia coronata** Corda, **Gymnosporangium mali-tremeloides** Kleb., **G. juniperi** Link, **Peridermium pini** Kleb., **Thekopsora padi** Kze. et Schum.

Sidenko, I.E. Bio-ekologicheskie osobennosti rzhavchiny i mery bor'by s etoi bolezn'yu (Bio-Ecological Properties of Rusts and Measures of Combating these Diseases). Synopsis of Report, Kharkov. 1955.

Sigrianskii, A.M. Glavneishie bolezni zernovykh kul'tur i podsolnechnika (Main Diseases of Grain Crops and Sunflower). — Nauchnaya konferentsiya po izucheniyu i razvitiyu proizvoditel'nykh sil Voronezhskoi oblasti. Synopses of Reports, pp. 120—122, Voronezh. 1940.

Smarods, J. Parskats par Latvijae PSR Rusas semen (Survey of Fungal Rusts of the Latvian SSR). — Izvestiya Akademii Nauk Latv. SSR, 7(60): 125—140. 1952.

Smarods, Yu. Mikologicheskie zametki (Mycological Notes). — Bot. mater. Otd. sporov. rast. Bot. inst. AN SSSR, Vol. 9 : 129 — 132. 1953.

The severe infection of **Mahonia aquifolium** Nutt. by stem rust is noted.

Smirnova, O. N. Izuchenie rzhavchiny v usloviyakh podtaezhnoi polosy Sibiri (Studies on Rusts of the Sub-Taiga Belt of Siberia). — Zashchita Rastenii, 12 : 190 — 191. 1937.

Smits'ka, M. F. Hrybni khvoroby derevnykh ta chaharnykovykh porid bukovykh lisiv Zakarpats'koyi oblasti (Fungal Diseases of Trees and Shrubs in the Beech Forests of the Transcarpathian Region). — Bot. Zhur. AN URSR, 12 (4) : 87 — 92. 1955. [In Ukrainian.]

Sobichevskii, V. T. Sovremennoe sostoyanie rastitel'noi patologii derev'ev i znachenie rastitel'nykh parazitov-gribkov pri vzrashchenii lesa (Present State of Tree Pathology and the Significance of Plant-Parasitic Fungi in Afforestation). — Lesnoi Zhurnal, 5 (4) : 1 — 28. 1875. Vol. 5 : 1 — 33; Vol. 6 : 53 — 93.

Sobichevskii, V. T. K voprosu ob **Aecidium pini** (**Aecidium pini**) — Lesnoi Zhurnal, 27 (3) : 460 — 464. 1897.

Sobolev, S. L. Rzhavchina khlebov v Severo-Kavkazskom krae v 1936 g. (Grain Rusts in the North Caucasian Territory in 1936). — Kratkie itogi rabot VIZR po rzhavchine khlebnykh zlakov za 1936 g., pp. 50 — 53, Izd. VIZR. 1937.

Sobolevskii, G. Sanktpeterburgskaya flora ili opisanie nakhodyashchikh-sya v Sanktpeterburgskoi gubernii prirodnykh rastenii (Flora of St. Petersburg, or a Description of the Natural Vegetation of St. Petersburg Province, Part II). SPb. 1802. 424 p.

Aecidia of **Aecidium tussilaginis** are described on pp. 378 — 379.

Sofyan, L. A. Bolezni seyantsev lesnykh porod v pitomnikakh severnykh raionov Armenii i mery bor'by s glavneishimi iz nikh (Diseases of Seedlings of Forest Trees in the Nurseries of the Northern Districts of Armenia and Measures of Combating the Main Fungi). — Izvestiya Akademii Nauk Armyanskoi SSR, 6 (1) : 27 — 42. 1953.

Melampsora pinitorqua Rostr.

Sokanovskii, B. **Peridermium pini** f. **corticola** Rabh. i ego vliyanie na massovoe razvitie lesnykh vreditelei (**Peridermium pini** f. **corticola** Rabh. and its Effect on the Outbreaks of Forest Pests). — Zashchita Rastenii, 3 : 117 — 122. 1932.

Sokolov, A. Spisok i kratkoe opisanie gribnykh vreditelei sadov i ogorodov m. Smely Kievskoi gub. za 1914 g., chast'yu za 1915 g. (A List and Brief Description of Fungal Pests of Orchards and Vegetable Crops in Smela, Kiev Province in 1914 and part of 1915). — Byulleten' o vreditelyakh sel'skogo khozyaistva i merakh bor'by s nimi, izdavaemyi Entomologicheskim i fitopatologicheskim byuro Khar'kovskogo gubernskogo zemstva, 3(7): 18—33. June — December, 1915.

Of the 84 species of fungi reported, 7 are rusts. In general, aecidia were found on **Berberis** and lettuce.

Sokolov, D. V. (et al). Vrediteli i bolezni polezashchitnykh lesnykh nasazhdenii i mery bor'by s nimi (Pests and Diseases of Shelter Belts and their Control), pp. 143—154. Moskva-Leningrad. 1951.

Six species of rust fungi are reported.

Sol'kina, A. F. Novye vidy parazitnykh gribov iz Turkestana (New Species of Parasitic Fungi from Turkestan). — Materialy po Mikologii i Fitopatologii, 7(1): 179—181. 1928.

Puccinia Drobovii sp. nov. and **Uromyces halimondendri** sp. nov. are described; teliospores of **P. Drobovii** are illustrated.

Solomakhina, V. M. Hrybni khvoroby derevnykh i chaharnykovykh porid okolyts' m. Poltavy ta polezakhysnykh lisovykh smug Karlivs'kogo raionu, Poltavs'koyi oblasti (Fungal Diseases of Trees and Shrubs on the Environs of Poltava and in the Shelterbelts of Karlovka District, Poltava Region). — Stud. nauk. pratsi Kyyivs'k. Derzh. univ., 14: 73—76. 1954. [In Ukrainian.]

Uromyces cytisi (Str.) Schroet., **Melampsora** allii-populina Kleb., **M. tremulae** Tul., **M. larici-capraearum** Kleb.

Solov'ev, F. A. Puzyrchataya rzhavchina sosny (Blistery Rust of Pine). — Zapiski Lesnoi Opytnoi Stantsii, Part 1, Vol. 6: 1—44, Leningrad. 1929.

Sorokin, N. V. Mikologicheskaya ekskursiya v Belgorod i Khoroshev (A Mycological Excursion to Belgorod and Khoroshev). — Protokoly zasedaniya Obshchestva ispytatelei prirody pri imperatorskom Khar'kovskom universitete, pp. 13—21. 1870.

Of the 28 species reported, 3 are of **Puccinia**.

Sorokin, N. V. Mikologicheskie issledovaniya (Mycological Research). — Trudy Kazanskogo Obshchestva Estestvoispytatelei, Vol. 2: 1—50. 1872.

Twenty species of rust fungi.

Sorokin, N. V. Materialy dlya flory Urala (Material for the Flora of the Urals). — Trudy Obshchestva Estestvoispytatelei pri Imperatorskom Kazanskom Institute, 5(6): 1—28. 1876a.

About 40 species of rust fungi.

Sorokin, N. V. O nekotorykh boleznyakh kul'turnykh rastenii Yuzhno-Ussuriiskogo kraya Primorskoi oblasti (Some Diseases of Cultivated Plants in the South Ussuri Territory of the Maritime Region). — Ibid., 22(3): 1—34. 1890.

Puccinia graminis is mentioned on p. 7.

Sorokin, N. V. O nekotorykh boleznyakh vinograda i drugikh rastenii Kavkazskogo kraya (Some Diseases of Grapes and Other Plants of the Caucasian Territory). — Otchet, predstavlennyi v Ministerstvo gosudarstvennykh imuchshestv i narodnogo prosveshcheniya Izd. Kavkazskogo filloksernogo komiteta, Tiflis. 1892. 146 p. Illustrated, 22 tables.

Species of **Phragmidium** on **Rubus** and **Rosa**.

Sorokin, N. V. and N. Bush. Materialy k mikologicheskoi flore Yuzhno-Ussuriiskogo kraya (Material for the Mycoflora of the South Ussuri Territory). — Trudy Obshchestva Estestvoispytatelei pri Imperatorskom Kazanskom Universitete, 24 (5) : 1 —3. 1892. (Preprint).

The list includes 23 species of rust fungi, indicating the host plants and collection sites. The material was collected by N. Pal'chevskii, mainly near the village of Grigor'evskoe.

Sosin, P. Materialy do flory hrybiv Kamya'nets'-Podil'skoyi oblasti (Material on the Mycoflora of the Kamenets-Podol'skii Region). — Bot. Zhurn., AN URSR, 1(1—2): 381—385. 1940. [In Ukrainian.]

Sovzdarg, V. Vrediteli i bolezni plodovykh i yagodnykh kul'tur (Pests and Diseases of Fruit and Berry Crops). Moskva-Leningrad. 1954. 144 p.

Spagorov, G. E. Materialy k flore parazitnykh gribov Khar'kovskoi gub. (Material on the Flora of Parasitic Fungi in Khar'kov Province). — Trudy Obshchestva Ispytatelei Prirody pri Khar'kovskom Universitete, Vol. 61: 149—168. (1915) 1916. With 4 plates.

Thirty-one species of rust fungi are reported (pp. 154—156).

Speshnev, N. N. Materialy dlya izucheniya mikologicheskoi flory Kavkaza. I. Gribnye parazity Goriiskogo uezda (Material for the Study of Caucasian Mycoflora. I. Fungal Parasites of Gori County). — Trudy Tiflisskogo Botanicheskogo Sada, Vol. 1: 65—78. 1895.

Twelve rust fungi from Gori County (formerly Tiflis Province) are described on pp. 70—71.

Speshnev, N. N. Materialy dlya izucheniya mikologicheskoi flory Kavkaza. II. Gribnye parazity Kakhetii (Material for the Study of Caucasian Mycoflora. II. Fungal Parasites in Kakhetia). — Ibid., Vol. 2 : 199—266. 1897.

Thirty-one names of rust fungi from the former Tiflis Province are listed on pp. 207—217.

Speshnev, N. N. Meterialy dlya izucheniya mikologicheskoi flory Kavkaza. III. (Material for the Study of Caucasian Mycoflora. III). — Ibid., Vol. 5 : 1—14. 1901a. (Preprint).

Two species are reported: **Uredo ipomeae** (non Brc.) N. Speschnew (= **Uredo Speschnewii** Sacc. et Syd.) on leaves of **Ipomeae** sp. from Kakhetia and **Peridermium columnaie** Kze. et Schum. on needles of **Abies Nordmanniana.**

Speshnev, N. N. Gribnye parazity (novye i menee izvestnye) Zakaspiiskoi oblasti i Turkestanskogo kraya (Fungal Parasites (New and Less Known) in the Transcaspian Region and Turkestan Territory). — Ibid., Vol. 5: 159—183. 1901b. With 2 plates.

Six species of rust fungi are reported among which **Uromyces euphorbiae-connatae** sp. nov. (= **Melampsora** sp.), **Puccinia zoegeae crinitae** sp. nov. (= **P. buharica** Jacz.) and **P. doremae** sp. nov. are new.

Spisok dubletov mikologicheskogo gerbariya Tsentral'noi fitopatologicheskoi stantsii (List of Duplicates in the Mycological Herbarium of the Central Phytopathological Station). — Bolezni Rastenii, Supplement 9 (4—5) : 2—18. 1915.

The list includes 442 species of which 126 are rusts.

Sredinskii, N. K. Materialy dlya flory Novorossiiskogo kraya i Bessarabii (Material for the Flora of Novorossiisk Territory and Bessarabia). Odessa. 1872—1873. 291 p.

Stepanov, K. M. Rasprostranenie infektsionnykh boleznei rastenii vozdushnymi techeniyami (Dissemination of Infectious Plant Diseases by Air Currents). — Trudy po Zashchite Rastenii, Seriya 2, Vol. 8 : 1—68. 1935. Illustrated.

Stepanov, K. M. Zimostoikost' buroi listovoi rzhavchiny pshenitsy (Hardiness of the Brown Leaf Rust of Wheat). — Kratkie itogi rabot VIZR. 1937.

Stepanov, K. M. Vliyanie tepla na razvitie uredostadii steblevoi rzhavchiny pshenitsy i buroi rzhavchiny rzhi (**Puccinia graminis** Pers. i **P. dispersa** Erickss. et Henn.) (The Effect of Heat on the Development of the Uredio-Stage of the Stem Rust of Wheat and the Brown Rust of Rye (**Puccinia graminis** Pers. and **P. dispersa** Erickss. et Henn.)). — Izvestiya Vysshikh Kursov Prikladnoi Zoologii Fitopatologii, No. 10 : 115—125. 1940a.

Stepanov, K. M. Temperatura vozdukha i prodolzhitel'nost' razvitiya uredostadii buroi rzhavchiny pshenitsy (**Puccinia triticina**) (Air Temperature and Duration of Development of the Uredio-Stage of Brown Rust of Wheat (**Puccinia triticina**)). — Vestnik Zashchity Rastenii, No. 4 : 32—134. 1940b.

Storchevskii, A. L. Zashchita semennikov lyutserny ot vreditelei i boleznei (Protection of Alfalfa Seed Plants from Pests and Diseases). Stavropol'. 1948. 48 p.

Rust of alfalfa mentioned.

Strakhov, T. D. Sostoyanie i perspektivy izucheniya rzhavchiny khlebnykh zlakov i mery bor'by s neyu v USSR (Present State and Prospects of the Study of Grain Rusts and their Control in the Ukrainian SSR). — In book: "Rzhavchina zernovykh kul'tur," Raboty I Vsesoyuznoi konferentsii po bor'be s rzhavchinoi zernovykh kul'tur, pp. 57—94, VASKHNIL. (1938) 1939.

Strakhov, T. D. Kombinova shkala dlya vyznachennya typiv imunnosti i stupenya urazhennya pshenytsi buroyu lystovoyu irzheyu — **Puccinia triticina** Erickss. (Combined Scale for Marking the Type of Immunity and Degree of Infection of Wheat by the Brown Leaf Rust, **Puccinia triticina** Erickss.). — Tr. Inst. Gen. i Selekts. AN URSR, Vol. 3 : 51—58. 1952. [In Ukrainian.]

Strakhov, T. D. and T. V. Yaroshenko. Rol' mikroelementov v povyshenii ustoichivosti rastenii k zabolevaniyam (The Role of Microelements in Raising the Resistance of Plants to Diseases). — Synopses of Reports, Konferentsiya po mikroelementam, pp. 192—195, AN SSSR. 1950.

According to the authors, microelements enhance the resistance of cereals to rust fungi.

Stukov, G. A. Ocherk flory Vostochnogo Zabaikal'ya (Survey of the Flora of Eastern Transbaikalia). — Chitinskoe otdelenie Priamurskogo otdeleniya imperatorskogo Russkogo Geograficheskogo obshchestva, Vol. 8 : 1—74, Chita. 1907.

Eleven species of rust fungi are reported. Material processed by V. G. Transchel.

Stychinskii. Bolezni sosny (Pine Diseases). — Russkoe Lesnoe Delo, 1 (20) : 980—983. 1893.

"The fungi ("**Aecidium pini**") settle on the tree at the height where in cross-section it is approximately 25—30 years old and without fail in the southern or western side of the trunk, i. e., according to the direction of the prevailing wind and in the parts most exposed to solar light and heat" (p. 981).

Sukhorukov, K. T. Fiziologiya bol'nogo rasteniya (Physiology of Diseased Plants). — In book: "Problemy immuniteta kul'turnykh rastenii," Trudy Maiskoi Sessii Akademii Nauk SSSR, pp. 17—21. 1935—1936.

Sukhorukov, K. T. Fiziologicheskie osnovy immuniteta khlebnykh zlakov k rzhavchine (The Physiological Basis of the Immunity of Cereals to Rust). — In book: "Rzhavchina zernovykh kul'tur," Raboty I Vsesoyuznoi konferentsii po bor'be s rzhavchinoi zernovykh kul'tur, pp. 204—210, VASKHNIL. (1938) 1939.

Sukhorukov, K. T. Fiziologiya immuniteta rastenii (Physiology of Plant Immunity). — Moskva, Izd. AN SSSR. 1952. 147 p.

Data on immunity to rust fungi are reported.

Sutulov, A. Materialy k flore Novo-Aleksandriiskogo uezda Lyublinskoi gubernii. Ocherk flory okrestnostei posada Opolya (Material for the Flora of Novaya-Aleksandriya County, Lublin Province. Survey of the Flora in the Environs of Opole). — Zapiski Novo-Aleksandriiskogo Instituta Sel'skogo Khozyaistva i Lesov, 22(2): 1—44, SPb. 1912.

The list comprises 48 species of rust fungi which were collected and identified by S. S. Ganeshin and G. S. Nevodovskii.

Syrovatskii, S. G. Itogi selektsionnoi raboty Voroshilovskoi stantsii po bor'be s rzhavchinoi na ustoichivost' zernovykh kul'tur k vidam rzhavchiny i golovni (Results of Selection at the Voroshilovsk Station on the Control of Rusts and Resistance of Grain Crops to Rust Species and Smut). — In book: "Rzhavchina zernovykh kul'tur," Raboty I Vsesoyuznoi konferentsii po bor'be s rzhavchinoi zernovykh kul'tur, pp. 105—110, VASKHNIL. (1938) 1939.

Syuzev, P. V. Materialy k mikologicheskoi flore Permskoi gub. (Material for the Mycoflora of Perm Province). — Bull. Soc. imp. natur. Moscou, Vol. 12(2—3): 320—329. 1898.

Of the 100 species of fungi listed, 49 are rusts (Nos. 31—78, and 92). The fungi were identified by Jaczewski.

Syuzev, P. V. Enumeratio fungorum in Oriente Extremo anno 1905 collectorum. — Trudy Botanicheskogo Muzeya Imperatorskoi Akademii Nauk, Vol. 7: 102—110. 1910.

The list comprises 25 species of rust fungi collected in the Far East and in Northern Manchuria.

Syuzev, P. V. Gribnye parazity, prichinyayushchie bolezni kul'turnym i poleznym rasteniyam v Permskoi gubernii (Fungal Parasites Responsible for Diseases of Cultivated and Useful Plants in Perm Province). Materialy po izucheniyu Permskogo kraya, Vol. 4: 151—158, Izdanie Permskogo nauchno-promyshlennogo muzeya, 1911.

Rust fungi on cereals and other plants are reported.

Syuzev, P.V. Novye dannye dlya flory okr. gor. Tomska (Additional Data on the Flora in the Environs of Tomsk). — Zhurnal Russkogo Botanicheskogo Obshchestva, Vol. 6 : 148—149. 1921.

Uromyces erythronii Pass. is reported.

Syuzev, P.V. Mikologicheskie materialy iz yugo-zapadnoi Rossii (Mycological Material from South-Western Russia). — Izvestiya Biologicheskogo Nauchno-Issledovatel'skogo Instituta i Biologicheskoi Stantsii pri Permskom Gosudarstvennom Universitete, 3(2): 167—168. 1924.

Several species of rust fungi are reported.

Tannuks, K.K. Dve opasnye bolezni kryzhovnika (Two Dangerous Diseases of Gooseberry). — Sitzungsber. Naturf.-Ges. Univ. Juriew, Vol. 15 : 62—65. 1906.

Puccinia (= **P. ribesii-caricis**) is mentioned among the dangerous inducers of disease on **Ribes grossularia**.

Targonskii, V.A. Sbornik svedenii dlya opredeleniya ubytkov, prichinyaemykh kul'turnym rasteniyam gradobitiyami i dr. atmosfericheskimi vliyaniyami, a takzhe nasekomymi i boleznyami (Collection of Data for the Determination of Damages Inflicted on Crops by Hail and Other Atmospheric Phenomena, and Also by Insects and Diseases). Moskva. 1890. 120 p.

According to the author, "the most widespread and dangerous pest of cereals is the well-known "rust" disease" (p. 43). Stem rust and the rusts of wheat and rye are discussed.

Teikh, A. Novye vidy mikoflory Srednei Azii (New Species of Mycoflora of Central Asia). — Byulleten' Sredneaziatskogo Gosudarstvennogo Universiteta, 19(24): 177—181. 1934.

New species described are: **Melampsora stelleriae** Teich on **Stellera Alberti** Rgl. and **S. chamaejasme** L.

Teterevnikova, D.N. Nablyudeniya nad biologicheskimi vidami **Puccinia graminis** Pers. (Biological Species of **Puccinia graminis** Pers.). — Bolezni Rastenii, 15(4): 155—175. 1926.

According to the author, the following specialized forms of **Puccinia graminis** Pers. were detected in Detskoe Selo, Leningrad Region, in 1926: **Puccinia graminis** Pers.: f. sp. **secalis**. f. sp. **avenae**, f. sp. **phlei pratensis**, f. sp. **tritici**. The first two forms were particularly widespread. Bibliography contains 21 references, almost all non-Russian.

Teterevnikova-Babayan, D.N. Nablyudeniya nad biologicheskimi vidami **Puccinia graminis** Pers. v Detskom Sele v 1926 i 1927 godakh (Observation of Biological Species of **Puccinia graminis** Pers. in Detskoe Selo in 1926 and 1927). — Ibid., 17(1—2): 35—50. 1928.

Experimental infections reported.

Teterevnikova-Babayan, D. N. Materialy po izucheniyu parazitnoi mikologicheskoi flory drevesnykh porod i kustarnikov v Armyanskoi SSR (Material for the Study of the Parasitic Mycoflora of Trees and Shrubs in the Armenian SSR). — Sbornik Nauchnykh Trudov Botanicheskogo Obshchestva Armyanskoi SSR, Vol. 4 : 53 — 62. 1940.

Rust fungi reported.

Teterevnikova-Babayan, D. N. O trekh novykh vidakh rzhavchinnykh gribov, naidennykh v Armyanskoi SSR (Three New Species of Rust Fungi Found in the Armenian SSR). — Doklady Akademii Nauk Armyanskoi SSR, 9 (2) : 75 — 79. 1948.

Puccinia armeniaca sp. nov. (III) on leaves **Carduus** sp., **Puccinia tomantheae** sp. nov. (III) on leaves **Tomanthea daraiaghezica** (Fom.) Tacht, and **Uredo tarchunii** sp. nov. on leaves **Artemisia dracunculus** L. are described.

Teterevnikova-Babayan, D. N. Rezul'taty izucheniya rzhavchinnykh parazitov v Armyanskoi SSR (Study of Uredinales Parasites in the Armenian SSR). — Sbornik Trudy Erevanskogo Gosudarstvennogo Universiteta, Seriya Biologii, Vol. 30 : 183 — 198. 1950a.

Teterevnikova-Babayan, D. N Bolezni klevera v Armyanskoi SSR (Clover Diseases in the Armenian SSR). — Sbornik Nauchnykh Trudov Armyanskogo Sel'skokhozyaistvennogo Instituta, No. 6 : 119 — 127. 1950b.

Brief diagnoses of **Uromyces fallens** (Desm.) Kern., **U. trifolii repentis** (Cast.) Liro, **U. minor** Schr., **U. nerviphicus** (Grogn.) Hots. are given. Bibliography contains 17 references.

Teterevnikova-Babayan, D. N. Bolezni drevesnykh porod i kustarnikov v Kotaiskom raione Armyanskoi SSR (Diseases of Tree and Shrub Species in the Kotaiskii Region of the Armenian SSR). — Ibid., Vol. 33 : 19 — 47. 1951.

Six species of rust are reported on willow, popular, hawthorn, serviceberry, raspberry and dogrose. Bibliography contains 27 references.

Teterevnikova-Babayan, D. N. Rzhavchinnye parazity kul'turnykh i dikorastushchikh rastenii Armyanskoi SSR (Uredinales Parasites of Cultivated and Wild Plants in the Armenian SSR). Erevan. 1952. 187 p.

Puccinia castellanae Fragoso, new for the USSR, and the new species Puccinia armeniaca, **P. tomantheae** and **Uredo tarchunii** are described. Historical data on the geographical distribution of rusts in the Armenian SSR (pp. 13 — 22). The harmfulness of certain species, some problems of evolution, and the species development of rust fungi are discussed. Bibiliography contains 112 references of which 101 are in the languages of the USSR minorities.

Teterevnikova-Babayan, D. N. Bolezni posevnykh i lugovykh kormovykh zlakov v Armyanskoi SSR (Diseases of Sown and Meadow Forage in the Armenian SSR). — Izd. Armyanskogo Universiteta, Erevan. 1954. 97 p. Ill.

Teterevnikova-Babayan, D. N. and A. A. Babayan. Obzor rabot po izucheniyu boleznei sel'skokhozyaistvennykh kul'tur v Armyanskoi SSR (Review of Studies on Diseases of Agricultural Crops in the Armenian SSR). — Armyanskii Nauchno-Issledovatel'skii Institut Tekhnicheskikh Kul'tur, Sbornik Trudov po Zashchite Rastenii, No. 2 : 3 — 25, Erevan. 1949.

According to the authors, about 160 species of rusts have been found in the Armenian SSR. Bibliography contains 89 references, including manuscripts.

Teterevnikova-Babayan, D. N., N. A. Kechek and T. G. Stepanyan. Bolezni lyutserny v Armyanskoi SSR (Diseases of Alfalfa in the Armenian SSR). — Izvestiya Akademii Nauk Armyanskoi SSR, Tekhnicheskie i Sel'skokhozyaistvennye Nauki, 3 (3) : 227 — 240. 1950.

Uromyces striatus Schr. on alfalfa is reported; measures of control indicated. **Uromyces Magnusii** Kleb. is mentioned. Bibliography contains 35 references.

Teterevnikova-Babayan, D. N. and D. G. Melik-Khachatryan. Bolezni nekotorykh kul'turnykh i dikorastushchikh kormovykh bobovykh rastenii Armyanskoi SSR (Diseases of Certain Cultivated and Wild Leguminous Forage Plants in the Armenian SSR). — Nauchnye Trudy Erevanskogo Gosudarstvennogo Universiteta, Vol. 38 : 57 — 76. 1953.

Rust fungi are given considerable study.

Teterevnikova-Babayan, D. N. and S. A. Simonyan. Bolezni subtropicheskikh kul'tur v Armyanskoi SSR (Diseases of Subtropical Crops in the Armenian SSR). — Izvestiya Akademii Nauk Armyanskoi SSR, 5 (1) : 65 — 78. 1952.

Gymnosporangium confusum Plowr. on quince and medlar; **Tranzschelia pruni-spinosae** (Pers.) Diet. on almond. Bibliography contains 26 references.

Tikhonen, A. P. Perechen' boleznei sel'skokhozyaistvennykh rastenii, a takzhe nekotorykh boleznei lesnykh porod v Bryanskoi gubernii v 1926 godu (List of Diseases of Agricultural Plants and of Certain Diseases of Forest Species in Bryansk Province in 1926). — Zashchita Rastenii ot Vreditelei, 4 (4 — 5) : 775 — 779. 1927.

Some species of rust fungi.

Transhel', V.G. K flore rzhavchinnykh gribov Arkhangel'skoi i Vologodskoi gubernii (Flora of Rust Fungi of the Arkhangel'sk and Vologda Provinces). — Botanicheskie Zapiski, izdavaemye pri Botanicheskom Sade Imperatorskogo Sankt Peterburgskogo Universiteta, 3(2): 129—134. 1891a.

Transhel', V.G. Novye ili maloizvestnye vidy rzhavchinnykh gribov (New or Little-Known Species of Rust Fungi). — Ibid., 3(2): 137—140. 1891b.

Transhel', V.G. O botanicheskikh issledovaniyakh v Balashevskom uezde Saratovskoi gubernii (Botanical Investigations in Balashov County, Saratov Province). — Trudy Sankt Peterburgskogo Obshchestva Estestvoispytatelei, Otdel Botaniki, Protokoly zasedaniya, Vol. 22: 29—30. 1891c.

Transhel' V.G. O nekotorykh novykh rzhavchinnikakh, naidennykh v Rossii za poslednee vremya (Some New Rust Found Recently in Russia). — Ibid., Vol. 23: 27—30. 1893a.

Transhel', V.G. O **Peridermium strobi** na **Pinus cembra** (**Peridermium strobi** on **Pinus cembra**). — Ibid., Vol. 25: 22. 1895a.

Transhel', V.G. O teleitosporakh gribov **Uredo articus** Lag., **Uredo Agrimoniae** DC. i **Melampsora alni** Thuem. (Teliospores of the Fungi **Uredo articus** Lag., **Uredo Agrimoniae** DC and **Melampsora alni** Thuem). — Botanicheskie Zapiski izdavaemye pri Botanicheskom Sade Imperatorskogo Sankt Peterburgskogo Universiteta, 4(2): 299—301. 1895b.

Detailed diagnoses of **Pucciniastrum arcticum** (Lag) Tranz. and **Melampsora alni** Thüm.

Transhel', V.G. Spisok gribov, sobrannykh v Valdaiskom uezde Novgorodskoi gubernii (List of Species Collected in Valdai County, Novgorod Province). — Trudy Presnovodnoi Biologicheskoi Stantsii Imperatorskogo Sankt Peterburgskogo Obshchestva Estestvoispytatelei, Vol. 1: 160—203. 1901a.

Ninety-four species of rust fungi (**Melampsoraceae** — 309—335, **Pucciniaceae** — 336—402).

Transhel', V.G. Materialy dlya mikologicheskoi flory Rossii. I. Spisok gribov, sobrannykh v Krymu v 1901 (Material for the Mycoflora of Russia. I. List of Fungi Collected in the Crimea in 1901). — Trudy Botanicheskogo Muzeya Imperatorskoi Akademii Nauk, Vol. 1: 47—75. 1902.

The reports of the rust fungi species (65) are generally accompanied by extensive and critical comments. Includes a bibliography.

Transhel', V.G. Novye sluchai geteretsii u rzhavchinnykh gribov (New Cases of Heteroecism among Rust Fungi). — Trudy Imperatorskogo Sankt Peterburgskogo Obshchestva Estestvoispytatelei, Protokoly zasedaniya, Vol. 34 (1), No. 7, pp. 203—204. 1903. See also: Centrbl. Bakteriol., Vol. 11, No. 3. 1903.

Transhel', V.G. O vozmozhnosti predugadyvaniya biologii raznodomnykh vidov rzhavchinnykh gribov na osnovanii morfologicheskikh priznakov (The Possibility of Predicting the Biology of Heteroecious Species of Rust Fungi on theBasis of Morphological Symptoms). — Ibid., Vol. 35 (1), No. 4, pp. 286—297. 1904a.

Transhel', V.G. Neues Fälle von Heteröcie bei den Uredineen. — Trudy Botanicheskogo Muzeya Imperatorskoi Akademii Nauk, Vol. 2 : 14—30. 1905a.

Transhel', V.G. Materialy dlya mikologicheskoi flory Rossii. II. Spisok gribov, sobrannykh v Krymu v 1902—1903 gg. (Material for the Mycoflora of Russia. II. List of Fungi Collected in the Crimea in 1902—1903). — Trudy Botanicheskogo Muzeya Imperatorskoi Akademii Nauk, Vol. 2 : 31—47. 1905b.

Transhel', V.G. Beiträge zur Biologie der Uredineen. Bericht über die im Jahre 1904 ausgeführter Kulturversuche. — Trudy Botanicheskogo Muzeya Imperatorskoi Akademii Nauk, Vol. 2 : 64—80. 1905c.

Transhel', V.G. Beiträge zur Biologie der Uredineen. — Trudy Botanicheskogo Muzeya Imperatorskoi Akademii Nauk, Vol. 3 : 37—55. 1906.

Transhel', V.G. Materialy k mikologicheskoi flore Kavkaza. I. Griby, sobrannye v Abkhazii Yu. N. Voronovym (Material for the Mycoflora of the Caucasus. I. Fungi Collected in Abkhaziya by Yu. N. Voronov). — Vestnik Tiflisskogo Botanicheskogo Sada, Vol. 12 : 1—5. 1908. (Preprint).

Nineteen species of rust fungi reported.

Transhel', V.G. Über einige Aecidien mit gelbbrauner Sporenmembran.— Trudy Botanicheskogo Muzeya Imperatorskoi Akademii Nauk, Vol. 7 : 111—116. 1910a.

Transhel', V.G. Griby i miksomitsety Kamchatki (Fungi and Myxomycetes of Kamchatka). — Trudy Kamchatskoi Ekspeditsii F. P. Ryabushinskogo, Botanicheskii Otdel, Vol. 2 : 537—576. 1914a.

The list comprises 82 species of rust fungi. Many species are extensively annotated. Descriptions of the following species are given: **Puccinia pleurospermi** Tranz. et Woronichin, **P. artemisiae-norvegicae** Tranz. et Woronichin, **Aecidium pleurospermi** Tranz. et Woronichin.

T r a n s h e l ' , V. G. O komandirovke na Saratovskuyu oblastnuyu sel'skokhozyaistvennuyu opytnuyu stantsiyu: opyty zarazheniya **Xanthium strumarium** parazitom podsolnechnika **Puccinia Helianthi**. Nablyudeniya o svyazi **Aecidium Tranzschelianum** Lindr. s **Puccinia** na **Stipa pennata** (On the Mission to the Regional Agricultural Experimental Station in Saratov: Infection Experiment of **Xanthium strumarium** with the Parasites of Sunflower, **Puccinia helianthi**. Observations on the Connection between **Aecidium Tranzschelianum** Lindr. with **Puccinia** on **Stipa pennata**). — Otchet o deyatel'nosti Rossiiskoi akademii nauk. po otdeleniyam fiziko-matematicheskikh nauk za 1919—1920 gg., p. 76. 1920.

T r a n s h e l ' , V. G. Opyty i nablyudeniya po biologii rzhavchinnykh gribov za 1914—1919 gg. (Experiments and Observations on the Biology of Rust Fungi in 1914—1919). — Bot. mater. Inst. sporov. rast. Gl. bot. sada RSFSR, 2 (6) : 83—86. 1923.

T r a n s h e l ' , V. G. K sistematike i biologii roda **Triphragmium auct.** (**Triphragmium** Link, **Triphragmiopsis** Naumov, **Nyssopsora** Arthur) (Systematics and Biology of the Genus **Triphragmium auct.** (**Triphragmium** Link, **Triphragmiopsis** Naumov, **Nyssopsora** Arthur)). — Zhurnal Russkogo Botanicheskogo Obshchestva, Vol. 8 : 123—132. (1923) 1925.

T r a n s h e l ' , V. G. Obzor moikh rabot po biologii rzhavchinnykh gribov s 1902 g. (Survey of My Work on the Biology of Rust Fungi from 1902). — Dnevnik Vsesoyuznogo s"ezda botanikov v Moskve v yanvare 1926 g., pp. 171—172. 1926.

T r a n s h e l ' , V. G. **Puccinia Aeluropodis** Ricker i **Uromyces Aeluropodis** n. sp., ikh geograficheskoe rasprostranenie i biologiya (**Puccinia Aeluropodis** Ricker and **Uromyces Aeluropodis** n. sp. (their Geographical Distribution and Biology)). — Ibid., pp. 172—173. 1926.

T r a n s h e l ' , V. G. O svyazi **Puccinia Miyoshiana** Diet. (na Spodiopogon) s **Aecidium Bupleuri-sachalinensis** Miya na vidakh Bupleurum, dokazannoi opytami (On the Connection of **Puccinia Miyoshiana** Diet. (on Spodiopogon) with **Aecidium Bupleuri-sachalinensis** Miya on Species of **Bupleurum** Experimentally Demonstrated). — Otchet o deyatel'nosti Akademii Nauk SSSR za 1925 g., p. 95. 1926.

T r a n s h e l ' , V. G. Rzhavchinnye griby v ikh otnoshenii k sistematike sosudistykh rastenii (Rust Fungi in their Relation to the Systematics of Vascular Plants). — Yubilenyi sbornik posvyashchenyi I. P. Borodinu, pp. 282—291. 1927a.

T r a n s h e l ' , V. G. Otchet o komandirovke v Krym (Report on the Expedition to the Crimea). — Otchet o deyatel'nosti Akademii Nauk SSSR za 1926 g. II. Otchet o nauchnoi komandirovke i ekspeditsii, pp. 99—101. 1927b.

Observations on the polyphagism of **Puccinia cynodontis** Desm., the exchange of hosts of **Melampsora Ari-populina** sp. nov., experiments with **P. simplex**, the possible connection of **Aecidium valerianeliae** Biv. with **Puccinia glumarum**.

Transhel', V. G. Yuzhno-Ussuriiskaya ekspeditsiya (Expedition to South Ussuri). — Ibid., pp. 74 — 78. 1927c. Map.

Observations on heteroecious species of rust fungi.

Transhel', V. G. Dal'nevostochnaya ekspeditsiya (Far-Eastern Expedition). — Ibid., pp. 99 — 100. 1930.

Observations on the heteroecism of some rust fungi are made.

Transhel', V. G. O prinadlezhnosti etsidiev na barbarise k **Puccinia pygmaea** Erickss. (The Relation of Aecidia on Berberis to **Puccinia pygmaea** Erickss.). — Doklady Akademii Nauk SSSR, No. 2 : 45 — 48. 1931.

Experimental infections revealed that aecidia on berberis belonged to **Puccinia pygmaea**.

Transhel', V. G. Rzhavchina kendyrya (**Melampsora Apocyni Tr.**) (Rust of Indian Hemp (**Melampsora Apocyni Tr.**)). — Zashchita Rastenii, No. 8 : 531 — 533. 1932.

Transhel', V. G. Novye vidy rzhavchinnykh gribov iz Sibiri (New Species of Rust Fungi in Siberia). — Trudy Botanicheskogo Instituta AN SSSR, Seriya II, Sporovye rasteniya, Vol. 1 : 267 — 273. 1933.

Eight species of rust fungi are described.

Transhel', V. G. "Pravilo Fishera" i "metod Transhelya" u rzhavchinnykh gribov ("Fischer's Law" and "Tranzschel's Method" in Rust Fungi). — Sovetskaya Botanika, No. 1 : 85 — 90. 1934a.

Transhel', V. G. Soveshchanie po bor'be s rzhavchinoi (Conference on the Control of Rusts). — Ibid., No. 1 : 104. 1934b.

The Conference was held at the All-Union Institute for Plant Protection from December 27 to 30, 1933.

Transhel', V. G. Promezhutochnye khozyaeva rzhavchiny khlebov i ikh rasprostranenie v SSSR (Intermediate Hosts of Grain Rusts and their Distribution in the RSSR). — Trudy po Zashchie Rastenii, Seriya II, Vol. 5 : 1 — 40. 1934c.

A detailed review of rust fungi on cereals (mainly biology).

Transhel', V. G. **Puccinia cynodontis** Desm. Mnogoyadnyi grib (**Puccinia cynodontis** Desm. Polyphagous Fungi). — Sovetskaya Botanika, No. 1 : 108 — 111. 1935a.

Transhel', V. G. Vishnevaya rzhavchina — **Leucotelium Cerasi** (Bereng.) n. gen. n. comb. i ee etsidial'naya stadiya (Cherry Rust, **Leucotelium Cerasi** (Bereng.) n. gen. n. comb. and its Aecidial Stage). — Ibid., No. 4 : 80 — 84. 1935b. With 2 plates.

Transhel', V. G. Rzhavchinnye griby kak pokazateli rodstva ikh khozyaev, v svyazi s filogenezom rzhavchinnykh gribov (Rust Fungi as Indicators of their Host's Kinship in Connection with the Phylogenesis of Rust Fungi). — Ibid., No. 6 : 133 — 134. 1936a.

Transhel', V. G. Dal'nevostochnye rzhavchinnye griby (**Uredo nervicola** Tranzschel, **Leucotelium padi** Tranz. n. gen. n. sp.) (Far-Eastern Rust Fungi (**Uredo nervicola** Tranzschel, **Leucotelium padi** Tranz. n. gen. n. sp.)). — Vestnik Dal'nevostochnogo Filiala AN SSSR, No. 20 : 178 — 179. 1936b.

Transhel', V. G. Mikologiya v SSSR za 20 let (Mycology of the USSR for the Past Twenty Years). — Sovetskaya Botanika, No. 5 : 103 — 116. 1937.

Transhel', V. G. K biologii rzhavchinnykh gribov Dal'nevostochnogo kraya (Biology of Rust Fungi in the Far-Eastern Territory). — Trudy Botanicheskogo Instituta AN SSSR, Seriya II, Sporovye rasteniya, Vol. 4 : 323 — 344. 1938.

Twenty-eight species (**Puccinia, Leucotelium, Nothoravenelia, Uropyxis, Aplospora**) are described of which 4 are new, one is a variety and one nom. nov. Results of experimental infection are presented.

Transhel', V. G. Obzor rzhavchinnykh gribov SSSR (Review of the Rust Fungi of the USSR). Leningrad. 1939. 426 p.

The book contains a broad introduction, keys to the determination of tribes and genera of rust fungi, a list showing rust species found in the USSR, their hosts and sites of occurrence (sources given), as well as an index of fungal species and host genera.

Transhel', V. G. Sovremennoe sostoyanie znanii po biologii rzhavchin khlebnykh zlakov (Present State of Knowledge on the Biology of Grain Rusts). — In book: "Rzhavchina zernovykh zlakov," Raboty I Vsesoyuznoi konferentsii po bor'be s rzhavchinoi zernovykh kul'tur, pp. 21 — 28, VASKHNIL. (1938) 1939.

Transhel', V. G., L. Gutner, and M. Khokhryakov. Spisok gribov, vstrechayushchikhsya na novykh kul'turnykh pryadil'nykh rasteniyakh (Catalogue of Fungi Occurring on New Textile Crops). — Trudy Instituta Novogo Lubyanogo Syr'ya VASKHNIL, 4 (1) : 127 — 140. 1937.

T r a n s h e l ' , V. G. and M. A. L i t v i n o v . Rzhavchinnye griby iz roda **Tranzschelia** Arth. na slivovykh (Rust Fungi of the Genus **Tranzschelia** Arth. on Prunes). — Botanicheskii Zhurnal, 24 (3) : 247 — 252. 1939.

The new species **Tranzschelia japonica**, **T. Arthuri** and **T. microcerasi** are described.

T r e b u , O. Spisok paraziticheskikh gribov, sobrannykh v Khar'kovskoi gub. (List of Parasitic Fungi Collected in Khar'kov Province). — Trudy Obshchestva Ispytatalei Prirody pri Khar'kovskom Universitete, Vol. 66 : 1 — 16. 1913. (Preprint).

The list comprises 121 species of rust fungi.

T r o p o v a , A. T. Gribnye zabolevaniya novykh tekhnicheskikh kul'tur i ispytanie nekotorykh mer bor'by (Fungal Diseases of New Industrial Crops and Experimentation with Some Methods of Control). — Severno-kavkazskaya, Rostovo Nakhichevanskaya na Donu Kraevaya sel'-skokhozyaistvennaya opytnaya stantsiya, Otdel Prikladnoi Botaniki, Byulleten', No. 247 : 1 — 14. 1928. With 11 illustrations.

Puccinia carthami Corda and **Puccinia** sp. on safflower are described. Two illustrations of teliospores.

T r o p o v a , A. T. Aktivnaya kislotnost' kletochnogo soka nekotorykh rastenii i porazhaemost' ikh gribkami i bakteriyami (Active Acidity of the Cellular Sap of Some Plants and their Infestation by Fungi and Bacteria). — Izvestiya po Opytnomu Delu Severo-Kavkaza, No. 13 : 3 — 16, Rostov-na-Donu. 1929.

The author presents data on infestation of **Helianthus**, **Pisum**, **Secale** and **Carthamus** by rust fungi ("**Puccinia** sp. sp."), indicating the pH of the cellular sap in these plants. No comparative data are given.

T r o p o v a , A. T. **Puccinia Jaczewskii** nov. sp. Tropova (Trudy sel'-skokhozyaistvennykh opytnykh uchrezhdenii). — Izvestiya po Opytnomu Delu Severo-Kavkaza, 5 (22) : 211 — 212, Rostov-na-Donu. 1930. With 3 plates.

T r o s h a n i n , P. G. Issledovanie zarazhennosti sosnovykh nasazhdenii opytnogo lesnichestva Tatrespubliki puzyrchatoi rzhavchinoi i "seryankoi" (Studies on the Susceptibility of Pine Stands to Infection with Blistery Rust and "Sulfur Match" at the Experimental Forestry Station in the Tatar Republic). — Lesnaya Opytnaya Stantsiya Tatres-publiki, Byulleten', No. 2. 1929.

T r o s h a n i n , P. G. Prichiny zabolevaniya seyantsev sosny v lesnykh pitomnikakh Tatrespubliki (Causes of Pine-Seedling Diseases in the Forest Nurseries of the Tatar Republic). Kazan. 1932. 39 p.

The author reports on the wide dissemination of **Melampsora pinitorqua** in nurseries and stands.

Troshanin, P. G. Sosnovyi vertun i ego vliyanie na formirovanie stvola (Pine-Twisting Rust and its Effect on the Development of Tree Trunks). — Sbornik Tatarskoi lesnoi opytnoi stantsii i Nauchno-inzhenernogo tekhnicheskogo Obshchestva lesovedov, Vol. 1 : 22 — 46, Kazan. 1938.

Troshanin, P. G. Mery ukhoda v sosnyakakh v svyazi s issledovaniem bolezni sosnovogo vertuna (Maintenance of Pine Forests in Connection with the Study of the Pine-Twisting Disease). — Bryanskii lesokhozyaistvennyi institut, Doklady, Sbornik 1, pp. 55 — 58, Bryansk. (1945 — 1947) 1947.

Troshanin, P. G. Sosnovyi vertun i bor'ba s nim (Pine-Twisting Rust and its Control). — Moskva-Leningrad, Goslesbumizdat. 1952. 46 p.

Melampsora pinitorqua Rostr. is described. A brief history of investigation, biology, pathogenicity, distribution and control are presented. Bibliography contains 31 references.

Trusova, N. P. Gribnye bolezni kul'turnykh i dikorastushchikh rastenii Tul'skoi gub. po nablyudeniyam v techenie leta 1911 goda (Fungal Diseases of Cultivated and Wild Plants in Tula Province in 1911). — Bolezni Rastenii, 6 (1 — 2) : 1 — 15. 1912.

Of the 119 species of fungi listed, 40 are rusts. Errata appear after index (No. 5 — 6).

Trusova, N. P. Gribnye bolezni kul'turnykh i dikorastushchikh rastenii Tul'skoi gub. po nablyudeniyam v techenie leta 1912 g. (Fungal Diseases of Cultivated and Wild Plants in Tula Province in 1912). — Ibid., 7 (5 — 6) : 205 — 217. 1913.

In the supplemental list of fungal diseases (see preceding work), 86 species are described, including 16 rusts.

Trusova, N. P. Obzor rastitel'nykh parazitov kul'turnykh i dikorastushchikh rastenii za 1913 god v Tul'skoi gubernii (Review of Plant Parasites of Cultivated and Wild Plants in Tula Province in 1913). — Materialy po Mikologii i Fitopatologii Rossii, 1 (4) : 35 — 56. 1915.

Nineteen species of rust fungi are described in this supplemental list (see lists puplished in 1912 and 1913).

Trusova, N. P. Eksperimental'noe issledovanie vliyaniya spor rzhavchiny na morskikh svinok (Experimental Study on the Effect of Rust Spores on Guinea Pigs). — Byulleten' III Vserossiiskogo entomo-fitopatologicheskogo s''ezda v Petrograde, pp. 8 — 15. 1921.

Trusova, N. P. Gribnye bolezni krasnogo klevera (Fungal Diseases of Red Clover). — Trudy Matochnyi semennoi rassadnik kormovykh trav "Uzkoe," Otchet za 1924 — 1925 gody, 1 : 96 — 102. 1927.

Uromyces trifolii Lév.

T r u s o v a, N. P. Bolezni krasnogo klevera i vliyanie ikh na urozhai semyan. Termicheskaya dezinfektsiya (Diseases of Red Clover and their Effect on Seed Yield. Heat Disinfection). — Kooperativnoe Izd. "Zhizn i znanie," pp. 211—218, Moskva. 1933.

The effect of **Uromyces trifolii** on clover seed yield.

T r z h e b i n s k i i, I. Perechen' nablyudaemykh v 1914 godu gribnykh zabolevanii kul'turnykh rastenii. Otchet za 1914 god o deyatel'nosti Stantsii okhrany rastenii (List of Fungal Diseases of Crops Recorded in 1914. Report on the Activities of the Plant Preservation Station for 1914), pp. 51—63, Varshavskoe Sadovoe Obshchestvo. (1914) 1915.

More than 10 rust species are described, some of them found in the border areas between Belorussia and the Ukraine.

T s e l l e, M. O. Grybnyyi khvoroby roslyn na Kyyivshchyni v 1923—24 (Fungal Diseases of Plants in the Kiev Area in 1923—1924). — Kyyivs'k. St. Zakh. Rosl. Vid. Shkidn. 1925. 28 p. [In Ukrainian.]

More than 70 species of rust fungi.

T s e r e t e l i, L. Rezul'taty nauchno-issledovatel'skoi raboty po izucheniyu boleznei zernovykh kul'tur (Results of Research into the Diseases of Grain Crops). — Tezisy dokladov II nauchnoi sessii Otdeleniya sel'skokhozyaistvennykh nauk AN Gruz. SSR, pp. 48—50. 1943.

T s o l k, K. G. Otchet praktikanta na dolzhnost' instruktora po bor'be s vreditelyami kul'turnykh rastenii (Report of an Instructor Trainee on the Control of Pests of Cultivated Plants). — Obzor razvitiya agronomicheskoi pomoshchi krest'yanskomu naseleniyu v severnoi chasti Liflyandskoi gubernii, Vol. 4: 266—268, Yur'ev. 1915.

Of the 22 species of fungi reported, 9 are rusts, parasitic on cultivated plants.

T s y m b a l, M. M. Meropriyatiya po bor'be s buroi rzhavchinoi pshenitsy v stepi USSR (Control Measures against Brown Wheat Rust in the Ukrainian Steppe). — Zemledelie, No. 1: 100—103. 1955.

T u m a r i n s o n, Kh. S. K fiziologicheskomu obosnovaniyu shkal ucheta vredonosnosti rzhavchin (Physiological Basis of the Gradation of Harmfulness of Rusts). — Trudy po Zashchite Rastenii, Seriya II, Vol. 6: 35—36. 1934.

T u m a r i n s o n, Kh. S. Kratkii otchet o nauchno-issledovatel'skoi rabote Vsesoyuznogo instituta po zashchite rastenii (Short Report on the Scientific Research Work of the All-Union Institute for Plant Protection), pp. 102—103, Leningrad. 1935.

T u p e n e v i c h, S. M. Bolezni lyupina v khozyaistvakh Semtresta v 1930 godu (Diseases of Lupine in the Semtrest (Seed Selection Trust) Farms in 1930). — Zashchita Rastenii, No. 1 : 81 — 96. 1932a.

Uromyces tupinicola Bubák.

T u p y a n e v i c h, S. M. Hrybnyya parazyty BSSR, sabranyya w letku 1928 i 1929 (Fungal Parasites in the Belorussian SSR Collected in 1928 and 1929). — Pratsy Gory-Goratskaga nav. tav., Vol. 7 : 215 — 234. 1930.

The list comprises 72 species of rust fungi collected in the Minsk Region.

T u p y a n e v i c h, S. M. Hrybnyya parazyty BSSR, sabranyya w 1930 i 1931 gg. (Fungal Parasites of the Belorussian SSR Collected in 1930 and 1931). — Zborn. prats., Part II, Belar. Akad. navuk, Inst. hyol. navuk, pp. 81 — 96, Minsk. 1932b.

34 species of rust fungi.

T y u l y u p a e v a, T. I. O povrezhdenii elovykh shishek rzhavchinnym gribkom **Pucciniastrum padi** (Kze. et Schm.) Diet. i shishkovoi listovertkoi **Laspeyresia strobilella** L. (**Grapholitha strobilana** Rtzw.) (On the Impairment of Spruce Cones Induced by the Rust **Pucciniastrum padi** (Kze. et Schm.) Diet. and the Cone Tortricid **Laspeyresia strobilella** L. (**Grapholitha strobilana** Rtzw.)). — Izvestiya Leningradskogo Lesnogo Instituta, Vol. 36 : 23 — 55. 1928.

Pucciniastrum padi (Kze. et Schm.) Diet is described.

U l' y a n i s h c h e v, V. I. Nekotorye dannye o rzhavchinnykh gribakh iz roda **Uromyces** (Some Data on Rust Fungi of the Genus **Uromyces**). — Trudy Instituta Botaniki AN Azerbaidzhanskoi SSR, Vol. 19 : 47 — 66. 1955.

U s t' y a n t s e v, M. M., V. A. B r y z g a l o v a, and K. A. M a m a e v. Glavneishie vrediteli i bolezni rastenii Vostochno-Sibirskogo kraya i mery bor'by s nimi (Main Pests and Diseases of Plants in Eastern Siberia and Measures of Combating Them). 1931. 97 p. Ill.

The section on plant diseases was prepared by V. A. Bryzgalova; rust fungi are described.

U t k i n, M. S. Vliyanie **Uromyces pisi** na urozhai sortov gorokha i prichiny razlichiya etogo yavleniya (The Effect of **Uromyces pisi** on the Yield of Pea Varieties). — Byulleten' III Vserossiiskogo entomo-fitopatologicheskogo s''ezda v Petrograde, pp. 31 — 32. 1921.

The effect of **Uromyces pisi** on the yield of red clover and the immunity revealed in different species of clover to this fungus (p. 31).

Utkin, M. S. K voprosu o kul'ture gorokha i vliyanie rzhavchiny na urozhai zerna i solomy raznykh sortov ego (Pea Crops and the Effect of Rusts on the Yield of Seed and Straw of Different Varieties). — Novaya Petrovka, No. 2 : 14—24. 1922.

Utkin, M. S. Yavlenie immuniteta raznykh vidov klevera k vidam roda **Uromyces** i vliyanie **Uromyces trifolii** na urozhai krasnogo klevera (The Immunity of Various Clover Species to Species of the Genus **Uromyces** and the Effect of **Uromyces trifolii** on the Yield of Red Clover). — Nauchno-Agronomicheskii Zhurnal, 1 (11) : 672—683. 1924.

Val'ts, Ya. Ya. O nekotorykh boleznyakh polevykh rastenii (Some Diseases of Field Plants). — Naturalist, 4 (7—9) : 105—107. 1867.

Several brief articles.

Val'ts, Ya. Ya. and L. Rishavi. Spisok kollektsii miksomitsetov i gribov, sobrannykh A. S. Rogovichem, Ya. Ya. Val'tsem i L. Rishavi (Catalogue of Collections of Myxomycetes and Fungi Collected by A. S. Rogovich, Ya. Ya. Val'ts and L. Rishavi). — Zapiski Kievskogo Obshchestva Estestvoispytatelei, 2 (2) : 187—189. (1871) 1872.

Melampsora salicina Lév., **Coleosporium rhinathacearum** DC, **Phragmidium obtusum** Schm., **Ph. incrassatum** Lk., **Puccinia graminis** De Bary, **P. coronata** Corda are reported from Kiev and its environs; **P. arundinacea** Hedw. and **P. helianthi** are reported from Kherson Province and 2 species of **Aecidium**.

Vanin, S. I. Parazitnye i saprofitnye griby drevesnykh porod v razlichnykh nasazhdeniyakh vostochnoi chasti Kasimovskogo uezda Ryazanskoi gub. (Parasitic and Saprophytic Fungi of Trees in Different Parts of the Eastern Part of Kasimov County in Ryazan Province). — Materialy po Mikologicheskim Obsledovaniyam Rossii, Vol. 3 : 37—74. 1916.

The list comprises 5 species of rust fungi.

Vanin, S. I. Vrediteli drevesnykh porod v razlichnykh nasazhdeniyakh Romanovskogo lesnichestva Tambovskoi gub. v 1918 g. (Pests of Trees in Different Parts of the Romanov Forestry Station of Tambov Province in 1918). — Bolezni Rastenii, Vol. 11 : 9—23. 1922.

Vanin, S. I. Gribnye vrediteli Khrenovskogo bora Voronezhskoi gubernii po dannym obsledovaniya v 1926 godu (Fungal Pests of the Khrenovoe Pine Forest in Voronezh Province According to a Survey Conducted in 1926). — Zashchita Rastenii, 4 (4—5) : 762—770. 1927a.

Caeoma pinitorquum is reported; of 447 14-year old trees, 90—or 20.1%—proved to be infected. The number of deformed trees, however, amounted to about 5% of all infected specimens.

Vanin, S. I. K mikologicheskoi flore Murmana (Contributions to the Mycoflora of Murman Coast). — Zashchita Rastenii, 4 (4—5): 770—772. 1927b.

Uredinales — 3 species: Chrysomyxa ledi, Melampsoridium-betulinum, Gymnosporangium juniperinum.

Vanin, S. I. Bolezni seyantsev i semyan lesnykh porod (Diseases of Seedlings and Seeds of Forest Trees). Leningrad. 1931. 152 p. With 86 illustrations.

Melampsoridium betulinum Kleb., **Melampsora pinitorqua** Rostr. and others are reported.

Vanin, S. I. Lesnaya fitopatologiya (Forest Phytopathology). 3rd ed. 1948. 354 p.

Manual of Forestry for Institutes of Higher Education; rust fungi of forest trees are described.

Vanin, S. I. O znachenii fitopatologii pri razvedenii polezashchitnykh lesonasazhdenii (The Importance of Phytopathology in Afforestation of Field Protective Belts). — Trudy Lesotekhnicheskoi Akademii im. S. M. Kirova, Vol. 66 : 62 — 77. 1949.

Rust fungi of forest trees are reported.

Varlikh, V. K. Parazitnye griby v Krymu letom 1895 goda (Parasitic Fungi in the Crimea in the Summer of 1895). — Sel'skokhozyaistvennyi i lesovodcheskii Zhurnal ministerstva Imushchestv, 183 (10) : 475 — 490. 1896.

Records and lists of fungi, including rusts.

Varlikh, V. K. Vazhneishie bolezni nashikh kul'turnykh rastenii, prichinyaemy parazitnymi gribami (The Most Important Diseases of our Cultivated Plants Caused by Parasitic Fungi). Vol. 1, SPb. 1897. 13 p. Vol. 2. 1898. 40 p.

Puccinia graminis Pers., **P. Rubigovera** DC, **P. coronata** Corda, **P. sorghi** Schw. and others.

Vasil'eva, L. N. O biologii rzhavchiny zernovykh kul'tur v Primorskom krae (Biology of Grain Rusts in the Maritime Territory). — Soobshcheniya Dal'nevostochnogo Filialai AN SSSR, Vol. 2 : 15 — 19. 1951.

Aeciospores from **Clematis manshurica** induced infection in "couch grass and **Regneria**." According to the author, the results of the experiments indicate that the aecia belong to the cycle of **Puccinia agropyrina** (in his opinion, **P. persistens** — brown leaf rust). The author did not take into account the work of V. A. Tranzschel, "Intermediate Hosts of Grain Rusts," which led to incorrect interpretations of experimental observations. The main mode of dissemination of overwintering rust in the Territory is by overwintering uredia. Bibliography contains 5 references.

Vasil'eva, L. N. Rzhavchina khlebnykh zlakov v Primorskom krae i mery bor'by s nei (Rusts of Graminous Grasses in the Maritime Territory and Means of their Control). Vladivostok. 1953. 39 p.

Vavilov, N. I. Materialy k voprosu ob ustoichivosti khlebnykh zlakov protiv paraziticheskikh gribov (Data on the Resistance of Cereals to Parasitic Fungi). — Trudy Selektsionnoi Stantsii pri Moskovskom Sel'skokhozyaistvennom Institute, Vol. 1 : 1—83. 1913a. With 3 colored plates.

Vavilov, N. I. Ocherki sovremennogo sostoyaniya ucheniya ob immunitete khlebnykh zlakov k gribnym zabolevaniyam (Data on the Present State of Studies on Immunity of Cereals to Fungal Diseases). — Trudy Selektsionnoi Stantsii pri Moskovskom Sel'skokhozyaistvennom Institute, Vol. 1 : 113—158. 1913b.

Vavilov, N. I. Immunitet rastenii k infektsionnym zabolevaniyam (Immunity of Plants to Infectious Diseases). — Izvestiya Petrovskoi Sel'skokhozyaistvennoi Akademii, Nos. 1—4 : 1—242. 1919. With 1 colored plate.

Vavilov, N. I. Uchenie ob immunitete rastenii k infektsionnym zabolevaniyam (Studies on the Immunity of Plants to Infectious Diseases). — Byulleten' Instituta Rastenievodstva, pp. 1—100, VASKHNIL. 1935. With 2 colored plates.

Vavilov, N. I. Zakonomernosti v raspredelenii immuniteta rastenii k infektsionnym zabolevaniyam (Patterns of Distribution of Plant Immunity to Infectious Diseases). — Trudy Maiskoi Sessii AN SSSR, pp. 5—16. 1935—1936.

Vavilov, N. I. Novye dostizheniya po bor'be s rzhavchinoi za granitsei (New Achievements in the Control of Rusts Abroad). — Zashchita Rastenii, 12 : 5—11. 1937.

Vavilov, N. I. Selektsiya ustoichivykh sortov kak osnovnoi metod bor'by s rzhavchinoi (Selection of Resistant Strains as a Primary Method of Rust Control). — In book: "Rzhavchina zernovykh zlakov," Raboty I Vsesoyuznoi konferentsii po bor'be s rzhavchinoi zernovykh kul'tur, pp. 3—20, VASKHNIL. (1938) 1939.

Vergovs'kii, V. Vrzha m'yati **Puccinia menthae** Pers. na **Mentha piperata** L. (Rust of Mint, **Puccinia menthae** Pers. on **Mentha piperata** L.). — Produkiyini syly Ukrayiny, Byulleten', No. 4 : 42—47, Kiyiv. 1929. [In Ukrainian.]

The author indicates the decline in the quality of essential oil in infected plants.

V e t, E. I. Materialy po mikoflore Karadinskogo leskhoza v svyazi s ee fitopatologicheskim znacheniem (Material for the Mycoflora of the Karadinskii Forestry Station in Connection with its Phytopathological Significance). — Trudy Saratovskogo Sel'skokhozyaistvennogo Instituta, 7(14):208—221. 1943.

Some species of rust fungi are reported.

V l a d i m i r s k a y a, M. E. Gribnye bolezni tsvetochnykh kul'tur (letnikov) (Fungal Diseases of Flower Cultures (Annuals)). — Botanicheskii Zhurnal SSSR, 38(6):817—829. 1953.

The list includes **Puccinia malvacearum** Mont., **P. antirrhini** Diet. et Holm., **P. asteris Duby**, **Cronartium** flaccidum (Alb. et Schw.) Wint.

V l a s o v, A. A. Porazhenie sosnovykh nasazhdenii puzyrchatoi rzhavchinoi v Prisurskom lesnom massive Chuvashrespubliki (Infection of Pine Plantations with Blistery Rusts in the Sura Forest Area of the Chuvash ASSR). — Izvestiya Kazanskogo Instituta Sel'skogo Khozyaistva i Lesovodstva, No. 2:1—46, Kazan. 1929. (Preprint).

A comprehensive survey. Reports on **Peridermium pini** in the Lyul'skii and Atratskii forestries of the Chuvash ASSR. Approximately 11,000 ha of forest were surveyed; special observations were made on 33 test plots with a total area of 8.34 ha. The article reports on observations (or general information) of the following problems: 1) life and distribution of the fungus **Peridermium pini** (process of infection, development of mycelium and spore formation); 2) the processes evolving in the trees exposed to infection (resinification, deposition of yearly rings, spread of the fungus along the trunk, external signs of the disease); 3) effect of the fungus on the growth and behavior of the tree (general picture, types of infection, fall of increment); 4) rate of infection of stands in the forests (distribution of infected trees according to Kraft dominance class; correlation of infection with age, type, site class, composition and density of stand; significance of relief, exposure, activity of man, forest fires); 5) damage inflicted by the fungus on the forest; 6) means of combating the disease. A program for the study of the fungus is attached. Bibliography contains 19 references.

V o i t c h i s h i n, N. V. Novye rzhavchinoustoichivye sorta ozimoi pshenitsy dlya predgorii Kavkaza (New Rust-Resistant Strains of Winter Wheat for the Foothills of the Caucasus). — Selektsiya i Semenovodstvo, No. 9:10—14. 1952.

New strains of winter wheat resistant to **P. graminis** were revealed by crossings of geographically remote rust-resistant forms.

V o i t c h i s h i n a, O. N. Formirovanie ustoichivosti k rzhavchine u gibridov ozimoi pshenitsy (Development of Rust-Resistance in Hybrids of Winter Wheat). — Selektsiya i Semenovodstvo, No. 5:31—33. 1953.

In hybrids of winter wheat treated by the author with leaf-feeding solutions of Ca, P, K and NaCl, increased resistance to brown rust was observed. This resistance was inherited by the subsequent generations. In the author's opinion top dressing may induce resistance to rust in hybrids of winter wheat.

Voitchishina, O. N. Vnekornevye podkormki kak priem, povyshayushchii ustoichivost' gibridov ozimoi pshenitsy k buroi rzhavchine (Leaf-Feeding as a Means of Increasing Resistance of Winter-Wheat Hybrids to Brown Rust). — In book: "Vnekornevaya podkormka sel'-skokhozyaistvennykh rastenii," pp. 238—241, Moskva, Sel'khozgiz. 1955.

Volod'ko, F. E. Rzhavchina i uvyadanie tsvetonosov kok-sagyza na torfyanykh pochvakh BSSR (Rusts and Wilting of Flower-Bearing Kok-Sagyz on the Peat Soils of the Belorussian SSR). — Izv. AN BSSR, No. 2 : 77—82. 1950.

Vol'skii, I. S. Bolezni i povrezhdeniya polevykh rastenii v Mogilevskom uezde Podol'skoi gubernii v 1909 g. (Diseases and Injuries of Field Plants in Mogilev County, Podol'skaya Province in 1909). — Khozyaistvo, No. 35 : 1,598—1,605, Kiev. 1910.

The author maintains that rust fungi develop most abundantly after autumn rains.

Voronikhin, N. N. Spisok gribov, sobrannykh v Buguruslanskom uezde Samarskoi gub. E. I. Ispolatovym v 1908—1910 gg. (List of Fungi Collected in Buguruslan County, Samara Province, in 1908—1910 by E. I. Ispolatov). — Izvestiya Imperatorskogo Sankt Peterburgskogo Botanicheskogo Sada, 11(1): 8—19. 1911.

Sixty-eight species of fungi are listed of which Nos. 16—50 are rusts.

Voronikhin, N. N. Spisok gribov, sobrannykh v Buguruslanskom uezde Samarskoi gub. E. I. Ispolatovym v 1910 g. II (List of Fungi Collected in Buguruslan County, Samara Province, in 1910 by E. I. Ispolatov. II). — Trudy Botanicheskogo Muzeya Imperatorskoi Akademii Nauk, Vol. 11 : 1—4. 1913.

Twenty-four fungal species are presented of which Nos. 3—22 are rusts, including a new species: **Aecidium Steveni** on **Campanula Steveni**.

Voronikhin, N. N. Materialy k mikologicheskoi flore Sochinskogo okruga. Spisok gribov, sobrannykh letom 1912 g., v Sochinskom okruge (Material for the Mycoflora of the Sochi District. List of Fungi Collected in the Sochi District in the Summer of 1912). — Trudy sochinskikh sadov i sel'skokhozyaistvennoi opytnoi stantsii, pp. 29—66, SPb. 1914a.

The list comprises 26 species of rust fungi.

Voronikhin, N.N. Spisok gribov, sobrannykh v Sochinskom okruge letom 1913 goda (List of Fungi Collected in the Sochi District in the Summer of 1913). — Vestnik Tiflisskogo Botanicheskogo Sada, Vol. 35 : 1—40. 1914b. With 1 table and 21 illustrations.

Of the 147 species listed, Nos. 41—48 are rust fungi.

Voronikhin, N.N. Materialy k mikologicheskoi flore Kavkaza. I. Griby iz kollektsii Kavkazskogo muzeya (Material for the Mycoflora of the Caucasus. II. Fungi from the Caucasian Museum Collection). — Izvestiya Kavkazskogo Muzeya, 9(1): 5—23, Tiflis. 1915a. With 7 illustrations.

Of the 135 species of fungi, Nos. 40—56 are rusts.

Voronikhin, N.N. Materialy k mikologicheskoi flore Kavkaza. II. Griby Areshskogo uezda iz kollektsii Kavkazskogo muzeya (Material for the Mycoflora of the Caucasus. II. Fungi of the Areshskii District from the Caucasian Museum Collection). — Ibid., 9(2): 111—124, Tiflis. 1915b.

Of the 85 species indicated, 4 are rust fungi.

Voronikhin, N.N. Materily dlya flory gribov Terskoi oblasti (Material for the Mycoflora of the Terek Region). — Materialy po Mikologii i Fitopatalogii Rossii, 1(3): 7—16, Petrograd. 1915c.

Of the 91 species listed, Nos. 12—35 are rusts.

Voronikhin, N.N. Dopolneniya k spisku gribov, sobrannykh v Sochinskom okruge letom 1913 g. (Supplement to the List of Fungi Collected in the Sochi District in the Summer of 1913). — Vestnik Tiflisskogo Botanicheskogo Sada, 12(3—4) : 1—23. 1916. (Preprint).

Of the 133 species listed, 12 are rust fungi.

Voronikhin, N.N. Materialy k mikologicheskoi flore Kavkaza. III. Griby iz kollektsii Kavkazskogo muzeya (Material for the Mycoflora of the Caucasus. III. Fungi of the Caucasian Museum Collection). — Izvestiya Kavkazskogo Muzeya, 10(1): 1—35, Tiflis. 1916. With 19 illustrations. (Preprint).

Of the 193 species listed, Nos. 70—95 are rusts.

Voronikhin, N.N. Ocherk flory sporovykh rastenii Talysha (Outline of the Sporophytic Flora of Talysh). — Ibid., Vol. 12 : 187—195. 1919.

Rust fungi are reported.

Voronikhin, N.N. Spisok gribov, sobrannykh Urmiiskoi ekspeditsiei 1916 g. (Index of the Fungi Collected by the Urmiiskaya Expedition in 1916). — Izvestiya Kavkazskogo Muzeya, Vol. 12 : 1—10. 1919.

Rust fungi are reported.

Voronikhin, N. N. Gribnye vrediteli kul'turnykh i dikorastushchikh poleznykh rastenii Gruzii v 1919 godu (Fungal Pests of the Cultivated and Wild Field Plants of the Georgian SSR in 1919). — Zapiski Nauchno-Prikladnogo Otdela Tiflisskogo Botanicheskogo Sada, Vol. 2 : 1—24. 1920.

Gymnosporangium sabinae, Phragmidium violaceum, Puccinia maydis, P. pruni-spinosae, Gymnosporangium.

Voronikhin, N. N. Gribnye i bakterial'nye bolezni s/kh. rastenii (Fungal and Bacterial Diseases of Agricultural Plants). Tiflis. 1922. 441 p.

An extensive list and description of rust fungi.

Voronikhin, N. N. Zametka o dvukh rzhavchinnykh gribakh: **Puccinia Coronillae** Woronich. i **Aecidium Coronillae** Woronich (Notes on Two Rust Fungi: **Puccinia coronillae** Woronich. and **Aecidium coronillae** Woronich). — Materialy po Mikologii i Fitopatologii, 5 (1) : 55—57. 1926. With 2 illustrations.

Voronikhin, N. N. Materialy k flore gribov Kavkaza (Material for Mycoflora of the Caucasus). — Trudy Botanicheskogo Muzeya Akademii Nauk SSSR, Vol. 21 : 87—252. 1927. With 2 plates.

The index comprises 1,073 fungal species of which 169 are rust species. The new species, **Puccinia picridium dichotoma** and **Uromyces galegicola** on **Galega**, are described.

Voronikhin, N. N. Gribnye i bakterial'nye bolezni tsitrusov (Fungal and Bacterial Diseases of Citruses). Moskva-Leningrad. 1937. 61 p.

Voronin, M. S. — Trudy Sankt Peterburgskogo Obshchestva Estestvoispytatalei, Protokoly, Vol. 1 : 30. 1870.

The author describes a branch of **Pinus strobus** from Levashov, infected with **Peridermium pini**.

Voronin, M. S. Issledovaniya nad razvitiem rzhavchinnogo gribka — **Puccinia healianthi**, prichinyayushchego bolezn' podsolnechnika (Studies on the Development of **Puccinia helianthi** Responsible for Diseases of Sunflower). — Trudy Sankt Peterburgskogo Obshchestva Estestvoispytatelei, 2 (2) : 157—189. 1871a.

The author traces the development of the rust **P. helianthi** in great detail. Sowings of **P. helianthi** teliospores on numerous Compositae and of spores from the latter on **Helianthus** do not induce infection; infection of **Helianthus tuberosus** by spores of **P. helianthi** also proved unsuccessful. A detailed account of rust control is given. The article is accompanied by 37 excellent color plates in two separate tables.

Voronin, M.S. **Cronartium ribesii** na **Ribes nigrum** v Petergofe i Peterburge (**Cronartium ribesii** on **Ribes nigrum** in Peterhof and Peterburg). — Trudy Sankt Peterburgskogo Obshchestva Estestvoispytatelei, Protokoly, Vol. 2 : 29. 1871b.

Voronin, M.S. O bolezni podsolnechnika (Diseases of Sunflower). — Zasedanie Peterburgskogo sobraniya sel'skikh khozyaev, No. 5 : 1—11. 1872.

A detailed account of information available on **Puccinia helianthi** and some other parasitic fungi. Control measures are thoroughly discussed.

Voronin, M.S. Dopolnenie k issledovaniyu nad boleznyu podsolnechnika (Supplement to Studies on Sunflower Diseases). — Trudy Sankt Peterburgskogo Obshchestva Estestvoispytatelei, Protokoly, Vol. 6 : 34—36. 1875.

Voronin, M.S. Prodolzhenie kursa mikologii, chitannogo na Zhenskikh meditsinskikh kursakh v techenie 1874—1875 gg. (Continuation of the Lectures on Mycology in the Series of Medical Courses for Women, Held in 1874 and 1875). 136 p.

Manuscript with illustrations.

Voronov, Yu.N. Materialy k flore Abkhazii. I. Spisok rastenii, dikorastushchikh i odichalykh, v Tsebel'dinskoi kotlovine i Petskiretskom ushchel'e (Material for the Flora of Abkhazia. I. Index of Wild Plants and of Plants Grown Wild in the Tsebel'da Basin and the Petskiretskoe Ravine). — Trudy Tiflisskogo Botanicheskogo Sada, 8(9) : 38—126. 1908.

The list of fungi comprises 102 items of which Nos. 15—37 are rust fungi.

Voronov, Yu.N. Materialy k mikoflore Kavkaza. I (Material on the Mycoflora of the Caucasus. I). — Ibid., 11(2) : 133—171. 1910.

Rust fungi: Family Melampsoraceae — 12 species, including the new species, **Coleosporium datiscae** Tranz., fam. Pucciniaceae — 101 species.

Voronov, Yu.N. Svod svědenii o mikoflore Kavkaza. Ch. I. Spisok gribov do sikh por izvestnykh dlya Kavkaza (Summary of Data on the Flora of the Caucasus. Part I. Index of the Fungi Known at Present in the Caucasus). Yu'rev. 1915. 200 p.

A long list (from p. 74 to 98) of rust fungi — 245 species including incomplete forms. The index is supplemented by reports on the host plants and by brief critical comments.

Voronov, Yu. N. Svod svedenii o mikoflore Kavkaza. Ch. II. (Summary of Data on the Flora of the Caucasus. Part II). — Trudy Tiflisskogo Botanicheskogo Sada, Seriya II, Vol. 3 : 1 — 186. 1922 — 1923.

The bibliography comprises 155 references. The list of collectors, 40 names, is included. Dessicate specimens — 5. In addition, 80 species of rust fungi, mainly species of **Uromyces** and **Puccinia** are reported, in addition to 5 incomplete forms. The total number of rusts in the Caucasus including the preceding indexes, amounts to 330 of which 26 are **Aecidium** and **Uredo**. Diagnoses of the new species — **Uromyces trifolii-echinati** Kuschke, **Puccinia doronici maerophylli** Kuschke, **P. mulgedii-cacaliaefolii** Kuschke.

Yablonskaya, E. Bolezni l'na v 1935 g. Glavnye vrediteli i bolezni sel'skokhozyaistvennykh kul'tur v SSSR (do 1935 g.) (Flax Diseases in 1935. Main Pests and Diseases of Crops in the USSR (up to 1935)), pp. 344 — 363, Leningrad. 1936. Charts 19 and 20, pp. 429 — 430.

Melampsora lini (Schum.) Desm.

Yachenskii, A. A. Katalog gribov Smolenskoi gubernii, sobrannykh v 1892 i 1894 godakh (Catalogue of Fungi Collected in Smolensk Province in 1892 and 1894). — Byulleten' Imperatorskogo Obshchestva Naturalistov, No. 1 : 128 — 148, Moskva. 1895.

Twenty-eight species of rust fungi are presented.

Yachevskii, A. A. Parazitnye griby russkikh lesnykh porod. Posobie dlya lesnichikh i lesovodov s 28 raskrashennymi tablitsami, ispolnennymi s natury V. Lyubimenko (Parasitic Fungi of Forest Trees in Russia. A Manual for Silviculturists and Foresters with 28 Color Plates taken from Nature by V. Lyubimenko). SPb. 1897b. 500 p.

The following rusts are described in detail (names according to the original text): **Caeoma laricis** Winter, **Coleosporium senecionis** Winter, **Aecidium elatinum** Kunze et Schmidt, **Chrysomyxa abietis** (Walir.) Winter, **C. ledi** Winter, **Melampsora betulina** Winter, **M. saliciscapraeae** Winter, **M. caprini** Winter, **M. populina** Cast., **Caeoma pinitorqua** A. Br., **Peridermium pini f. corticola** Lev., **Cronarium ribicola** Dietr., **Puccinia buxi** DC. Bibliography contains about 50 references.

Yachevskii, A. A. Opredelitel' gribov (Key to Fungi). Moskva. 1897. 240 p.

Yachevskii, A. A. Gribnye bolezni kukuruzy (Fungal Diseases of Indian Corn). SPb. 1900. 9 p.

Yachevskii, A. A. Gribnye parazity kul'turnykh rastenii. VI. Rzhavchina nashikh khlebnykh zlakov (Fungal Parasites of Cultivated Plants. VI. Russian Grain Crop Rusts). — Departament zemledeliya. SPb. 1901. 14 p.

Yachevskii, A.A. Rzhavchinnye griby (Rust Fungi). — In book: "Polnaya entsiklopediya russkogo sel'skogo khozyaistva," Vol. 8 : 396—413. 1903.

Yachevskii, A.A. Ezhegodnik svedenii o boleznyakh i povrezhdeniyakh kul'turnykh i dikorastushchikh poleznykh rastenii (Yearbook of Diseases and Pests of Cultivated and Beneficial Plants). — Trudy byuro po Mikologii i Fitopatologii, Uchenaya komissiya Glavnogo upravleniya zemlevstroistva i zemledeliya, Petrograd, Vol. 1. 1903 (1904); Vol. 2, 1904 (1906); Vol. 3, 1907 (1908); Vol. 4, 1908 (1909); Vol. 5, 1909 (1910); Vol. 6, 1910 (1912); Vol. 7—8, 1911—1912 (1917).

The Yearbook contains a large number of articles and notes on the distribution of rust fungi.

Yachevskii, A.A. Rzhavchina plodovykh derev'ev (Rusts of Fruit Trees). — Listok dlya bor'by s boleznyami i povrezhdeniyami kul'turnykh i dikorastushchikh poleznykh rastenii, 4(4) : 37—42. 1905a.

Yachevskii, A.A. Rzhavchina roz (Rose Rust). — Ibid., 4(6) : 55—58. 1905b.

Yachevskii, A.A. Rzhavchina smorodiny i kryzhovnika (Rusts of Currant and Gooseberry). — Ibid., 4(7) : 61—65. 1905c.

Yachevskii, A.A. Rzhavchina khlebnykh zlakov v Rossii (Rusts of Grain Crops in Russia). — Ibid., No. 4 : 1—187. 1909a. With 66 illustrations.

Yachevskii, A.A. Sparzhevaya rzhavchina (Asparagus Rust). — In book: "Polnaya entsiklopediya russkogo sel'skogo khozyaistva," Vol. 9 : 220—221. 1909b.

Yachevskii, A.A. Bolezni rastenii. (Fitopatologiya) (Plant Diseases (Phytopathology)). Vol. 1. SPb. 1910. 456 p. Vol. 2. 1911. 192 p.

A comprehensive work on phytopathology, which the author did not complete.

Yachevskii, A.A. O gribnykh boleznyakh lesnykh porod i o merakh bor'by s nimi (Fungal Diseases of Forest Trees and Means of their Control). SPb. 1911. 16 p.

Yachevskii, A.A. Opredelitel' gribov (A Key to Fungi). 2nd edition. SPb. 1913a. 11 + 932 p.

Key to species of rust fungi, list of species and their hosts, lists of different economic species. (See **Uredinaceae**, pp. 440—497).

Yachevskii, A.A. Gribnye bolezni khlebov, kartofelya, kapusty, yabloni i kryzhovnika (Fungal Diseases of Grains, Potatoes, Cabbages, Apples and Gooseberry). SPb. 1913b. 50 p.

Yachevskii, A.A. K voprosu o predpolagaemoi yadovitosti spor golovnevykh i rzhavchinnykh gribkov dlya nashikh domashnikh zhivotnykh (Concerning the Supposed Toxicity of Spores of Rust and Smut Fungi for Domestic Animals in Russia). — Listok dlya bor'by s boleznyami i povrezhdeniyami kul'turnykh i dikorastushchikh poleznykh rastenii, 3(12): 97—106. 1914.

Yachevskii, A.A. O razvitii **Gymnosporangium juniperinum** W. O koronchatoi rzhavchine na lomkoi krushine (The Development of **Gymnosporangium juniperinum** W. Crown Rust of the Alder Buckthorn). — Materialy po Mikologii i Fitopatologii Rossii, 1(2): 56. 1915.

Yachevskii, A.A. Gribnye i bakterial'nye bolezni klevera (Fungal and Bacterial Diseases of Clover). Tula. 1916. 61 p.

Yachevskii, A.A. Referat kn.: N.I. Vavilov. Zakon gomologicheskikh ryadov v nasledstvennoi izmenchivosti (1920, Trudy Saratovskogo S"ezda) (Abstract of the Book by N.I. Vavilov: "The Law of Homologous Series in Hereditary Variability" (Trudy Saratovskogo S"ezda)). — Materialy po Mikologii i Fitopatologii Rossii, 4(1): 100—104. 1922.

The author cites different forms of the genus **Puccinia** and other genera of Uredinales as examples of homologous variability.

Yachevskii, A.A. O bolezni sliv v Amurskoi oblasti (Prune Diseases in the Amur Region). — Izvestiya Amurskoi Oblastnoi Sel'skokhozyaistvennoi Opytnoi Stantsii, Vol. 3: 36—37, Blagoveshchensk. 1925.

Diseases caused by rusts are reported.

Yachevskii, A.A. Kratkii predvaritel'nyi otchet Mikologicheskoi laboratorii im. Yachevskogo za 1924 god. (Brief Preliminary Report of the Yachevskii Mycological Laboratory for 1924). — Zashchita Rastenii ot Vreditelei, 2 (7): 614—623. 1926a.

The author reports on the mycological collections of Benua, Rozhdestvenskii and others.

Yachevskii, A.A. O redkom rzhavchinnom gribke **Chrysomyxa (Barclayella) deformans** Jacz. (A Rare Rust Fungus **Chrysomyxa (Barclayella) deformans** Jacz.). — Izvestiya Leningradskogo Lesnogo Instituta, Vol. 33: 131—148. 1926b.

A detailed description of the fungus (systematic position, biology, distribution and harmfulness).

Yachevskii, A.A. O boleznyakh maslenichnykh rastenii (Diseases of Oleaginous Plants). — Masloboino-Zhirovoe Delo, 4(33): 11. 1928.

Yachevskii, A.A. Kartochnyi katalog Vsesoyuznoi mikologicheskoi flory, 1905—1930 (Card Catalogue of the All-Union Mycoflora, 1905—1930).

An alphabetical card catalogue of fungi compiled by A.A. Yachevskii and M.G. Antokol'skaya. Each card bears the name of the fungi, the habitat, substrate, date, name of the collector, and the person who has identified the fungus. The catalogue is available at the Mykological and Phytopathological Laboratory of VASKHNIL (Leningrad).

Yachevskii, A.A. Spravochnik fitopatologicheskikh nablyudenii (Manual of Phytopathological Observations). Leningrad. 1930. 237 p.

Lists parasitic fungi according to host plants. Fungi known in the USSR are listed.

Yachevskii, A.A. Bolezni polevykh rastenii (Diseases of Field Plants). Moskva-Leningrad. 1931. 77 p.

Yachevskii, A.A. Malyi kartochnyi katalog 1924—1931 gg. (A Concise Card Catalogue, 1924—1931).

An alphabetical card catalogue of the fungal collections at the Herbarium of the Mycological and Phytopathological Laboratory. After 1931 all collections were entered in separate catalogues. Also located in the same place (see above).

Yachevskii, A.A. Ustoichivost' sortov ovsa protiv koronchatoi rzhavchiny po dannym sortouchastka Shadrinskoi opytnoi stantsii v 1928 g. (Resistance of Oats to Crown Rust according to Data of the Shadrinskaya Experimental Station, 1928). — Trudy po Prikladnoi Botanike, Genetike i Selektsii, Seriya 5 (Grain Crops), No. 1: 135—146. 1932.

Yachevskii, A.A. Osnovy mikologii (Fundamentals of Mycology). Moskva-Leningrad. 1933. 1036 p.

Yakovlev, M.O. Spysok khvorob sadovnykh i horodnikh kul'tur raionu Mliivskoyi dosludnoyi stantsii (List of Diseases of Fruits and Vegetables at the Mliivskaya Experimental Station). — Pratsi Mliivsk. sadovo-gorodnoyi doslidn. st., Viddil Fitopatol., Vol. 44: 1—13, Mliiv. 1930. [In Ukrainian.]

Some species of rust fungi.

Yakubtsiner, M.M. Pshenitsa, ustoichivaya protiv gribnykh zabolevanii (**Triticum timopheevi** Zhuk.) (Wheat Resistant to Fungal Diseases (**Triticum timopheevi** Zhuk.)). — Trudy po Prikladnoi Botanike i Selektsii, Seriya A, No. 11: 121—130. 1934. With 1 illustration.

Yanitskii, I. O povrezhdeniyakh sosnovykh nasazhdenii puzyrchatoi rzhavchinoi (Damage Inflicted on Pine Stands by Blistery Rusts). — Lesnoi Zhurnal, 25(6): 797—819. 1895.

A very thorough study of the effects of fungi on the growth and condition of the infected trees. Measurements and other data are shown in 3 tables and a diagram.

Yaroshenko, T. V. Mikologiya i fitopatologiya v Khar'kovskom universitete v posleoktyabr'skii period (1917—1955) (Mycology and Phytopathology at Khar'kov University in the Post-Revolutionary Period (1917—1955)). — Uchenye Zapiski Khar'kovskogo Universiteta, Vol. 59 : 195—226. 1955.

Yunitskii, A. A. Zarazhennost' lesov Mariiskoi oblasti gribnymi zabolevaniyami, razrushayushchimi zdorovuyu i goreluyu drevesinu, i vred ot nikh dlya poyavivshikhsya molodnyakov na garyakh i koroednikakh po obsledovaniyam Mariiskoi ekspeditsii v 1926 g. (Infection of Forests in the Mari Region, Destruction of Healthy and Burned Trees Appearing on the Damaged and Burned Sites, as Reported by the Mari Expedition in 1926). — Izvestiya Kazanskogo Instituta Sel'skogo Khozyaistva i Lesovodstva, Vol. 3 : 98—111. 1927.

Rust fungi found in the forests of the Mari Region are reported.

Yunitskii, A. A. Vazhneishie gribnye vrediteli lesov Kazanskogo kraya (Major Fungal Pests in the Forests of Kazan Territory). — Dnevnik Vsesoyuznogo s"ezda botanikov v Leningrade v yanvare 1928 g., pp. 191—192, Leningrad. 1928.

Fungal rusts reported.

Yurgenson, P. B. Michurinskoe sredstvo protiv rzhavchiny roz (Michurin's Reagent in the Control of Rose Rust). — Priroda, No. 3 : 108—109. 1952.

Zaitseva, A. Khimicheskie mery bor'by s kok-sagyznoi rzhavchinoi (Chemical Measures against Kok-Sagyz Rust). — Doklady VASKHNIL, Nos. 2—3 : 45—47. 1944.

Zaitseva, A. I. O spetsializatsii vozbuditelya rzhavchiny kok-sagyza (Specialization of Agents of Kok-Sagyz Rusts). — Ibid., No. 9 : 31—40. 1947.

The author is of the opinion that kok-sagyz is parasitized by a special form of rust: **Puccinia taraxaci** f. **kok-sagyz** Zaitseva. This form is not infestive on other species of dandelion. The author does not describe the forms.

Zaitseva, A. I. K biologii vozbuditelya rzhavchiny kok-sagyza (Biology of Kok-Sagyz Rust). — Doklady Timiryazevskoi Sel'skokhozyaistvennoi Akademii, Vol. 7 : 136. 1948.

Cultures are described.

Zaitseva, A.A. and E.P. Popova. K voprosu o vliyanii sery na razvitie spor burogo rzhavchinnika (The Effect of Sulfur on the Spore Development of Brown Rust). — Zashchita Rastenii, No. 2 : 75 — 77. 1932.

Zak, G.A. and P.P. Treskin. Bolezni i vrediteli drevesnykh porod v polezashchitnykh lesonasazhdeniyakh (Diseases and Pests of Trees in Shelterbelts). Kuibyshev. 1952. 182 p. Illustrated.

Zakharzhevskaya, M.I. Vliyanie vnekornevoi podkormki na ustoichivost' sel'skokhozyaistvennykh rastenii k zabolevaniyam i na urozhai (The Effect of Leaf-Feeding on the Resistance of Crops to Disease and on the Crop Yield). — In book: "Vnekornevaya podkormka sel'skokhozyaistvennykh rastenii," pp. 257 — 259, Moskva, Sel'khozgiz. 1955.

Zaprometov, N.G. Iz nablyudenii nad gribnymi boleznyami kul'turnykh rastenii v Turkestane v 1915 g. (Observations of Fungal Diseases of Cultivated Plants in Turkestan in 1915). — Turkestanskoe Sel'skoe Khozyaistvo, pp. 1 — 27. Preprint. 1916.

Rust fungi on poplar, rose, mallow, and other plants.

Zaprometov, N.G. Materialy po mikoflore Srednei Azii (Material for the Mycoflora of Central Asia), Vol. 1 : 36, Tashkent. 1926.

The list includes 109 species of rust fungi, showing their distribution and hosts.

Zaprometov, N.G. Materialy po mikoflore Srednei Azii (Material for the Mycoflora of Central Asia), Vol. 2 : 70. 1928a.

Among the 169 species of rust fungi reported are the new species: **Uromyces halimodendri** Solkina on **Halimodendron argenteum** L., **Puccinia psoraleae** Zaprometov on **Psoralea drupacea** Bge., **P. Zozimiae** Zaprometov on **Zozimia dosicarpa** L., species of **Aecidium**. Nos. 1 — 2 are appended by an alphabetical index of the host plants. Bibliography contains 45 references of which 24 are in Russian.

Zaprometov, N.G. Novosti mikoflory Srednei Azii (News of the Mycoflora of Central Asia). — Dnevnik Vsesoyuznogo s"ezda botanikov v Leningrade, pp. 174 + 175. 1928b.

Zemit, V.E. Ob immunitete sortov l'na-dolguntsa k rzhavchine (On the Immunity of Spinning Flax Varieties to Rust). — Selektsiya i Semenovodstvo, No. 9 : 54 — 59. 1919.

The author reports on his observations on the susceptibility of spinning-flax varieties to the rust **Melampsora lini** and the possible causes of the disappearance of resistance.

Zemit, V.E. Biologicheskii sposob opredeleniya ustoichivosti l'nadolguntsa k rzhavchine (Biological Means of Determining the Rust Resistance of Common Flax). — Agrobiologiya, No. 2: 98—104. 1947.

Zerova, M.Ya. Irzha sadovogo bal'zaminu (**Impatiens balsami** na **Linum**) vyklykana **Puccinia** sp. (Rust of Garden Balsam (**Impatiens balsami** on **Linum**) Caused by **Puccinia** sp.). — Visn. Kyyvs'k. bot. sadu, Vol. 18: 91—94. 1947.

The author assumes that the rusts detected on balsam in the Botanical Gardens of Kiev and elsewhere were caused by either **Puccinia argentata** (Schulz) Winter or **P. Komarovi** Tranz.

Zerova, M.Ya. Materialy k izucheniyu mikoflory i gribnykh boleznei kievskikh zelenykh nasazhdenii. I. Phycomycetes, Ascomycetes, Basidiomycetes (Material for the Study of Mycoflora and Fungal Diseases of Amenity Stands in Kiev. I. Phycomycetes, Ascomycetes, Basidiomycetes). — Bot. Zhur. AN URSR, 5(2): 100—113. 1948.

Eleven species of rust fungi.

Zerova, M.Ya. Parazitnaya mikoflora lesonasazhdenii Pravoberezh'ya Ukrainskoi SSR (Parasitic Mycoflora of Forest Stands of the Right-Bank (of the Dnieper River) Area of the Ukrainian SSR). — Bot. Zhur. URSR, 10(4): 66—74. 1953.

Zhdanov, L.A. Selektsiya podsolnechnika na ustoichivost' k rzhavchine i zarazikhe (Donskaya opytno-selektsionnaya stantsiya) (Selection of Sunflower According to Resistance to Rust and Broomrape (Don Selection and Experimental Station)). — In book: "Kratkii otchet o nauchno-issledovatel'skoi rabote Vsesoyuznogo issledovatel'skogo instituta maslichnykh i efiromaslichnykh kul'tur za 1954 g.," pp. 18—24, Krasnodar. 1955.

Zhdanov, L.A. Selektsiya podsolnechnika na ustoichivost' k zarazikhe i rzhavchine (Selection of Sunflower According to Resistance to Rust and Broomrape). — Doklady VASKHNIL, Vol. 2: 14—19. 1956.

Zhilyakov, N.P. Spisok gribov, parazitiruyushchikh na drevesnykh porodakh C.-Peterburgskoi gubernii (List of 32 Rust Fungi Species Parasitizing Tree Species in St. Petersburg Province). — VIII s"ezd russkikh estestvoispytatelei i vrachei v S.-Peterburge, Otdel 5, Botanika, pp. 84—89, SPb. 1890.

Zhudra, P. Pis'ma iz Moskvy. II. Dve ekskursii (Letters from Moscow. II. Two Excursions). — Lesnoi Zhurnal, Vol. 9: 590—594. 1882.

Report on **Caeoma pinitorquum** in Moscow Province.

Zhuk, K.A. Rol' dinamiki razvitiya l'na-dolguntsa v povyshenii ego bolezneustoichivosti i urozhaya (The Role of the Dynamics of Development in Raising the Resistance to Disease of Spinning Flax and in Increasing its Yield). — Doklady Timiryazevskoi Sel'skokhozyaistvennoi Akademii, Vol. 10: 173—177. 1949.

Melampsora lini-usitatissimi.

Zhuravlev, I.I. and T.E. Osmolovskii. Glavneishie vrediteli i bolezni zelenykh nasazhdenii (The Main Pests and Diseases of Amenity Stands). Leningrad-Moskva. 1949. 208 p.

Several species of rust fungi reported.

Ziling, M.K. Griby Dal'nevostochnogo kraya (Fungi of the Far Eastern Territory). — Trudy Botanicheskogo Instituta AN SSSR, Seriya II, Sporovye rasteniya, Vol. 3: 679—697. 1936.

Forty-seven species of rust fungi.

Zolotnitskii, V.A. Selektsiya yarovoi pshenitsy v Amurskoi oblasti na ustoichivost' protiv rzhavchiny (Selection of Summer Wheat in the Amur Region According to Rust Resistance). — In book: "Rzhavchina zernovykh kul'tur," Raboty I Vsesoyuznoi konferentsii po bor'be s rzhavchinoi zernovykh kul'tur, pp. 149—160, VASKHNIL. (1938) 1939.

Zubachevskii, V. **Trametes pini** i **Peridermium pini corticola** (**Trametes pini** and **Peridermium pini corticola**). — Listok dlya bor'by s boleznyami i povrezhdeniyami kul'turnykh i dikorastushchikh poleznykh rastenii, 1(11): 84—87. 1902.

Zybina, S.P. O selektsii l'na na ustoichivost' k zabolevaniyam (Selection of Flax According to its Resistance to Disease). — Trudy po Prikladnoi Botanike, Genetike i Selektsii, Supplement, 74: 33—51. 1935.

Data on the susceptibility of flax to rust in different geographical areas.

Publications in Other Languages

(Non-Russian authors on the fungi of Russia—USSR)

Anderson, F. W. Notes on Certain Uredineae and Ustilagineae.— Journ. Mycology, 6 (3) : 121—127. 1890.

The author describes Puccinia kamtschatkae Anders. (=Phragmidium rosae (Barcl.) Tranz.) on Rosa, collected by Wright in Kamchatka near Petropavlovsk at the time of the North American expedition to theNorth Pacific (1853—1856).

Arthur, J. Eine auf die Struktur und Entwicklungsgeschichte begründete Klassifikation der Uredineen. — Résult. scient. Congr. intern. bot., Vienna. 1905, 1906. 331 pp.

Arthur, J. Interpretation of Rule 49 bis.— Mycologia, 26 (5) : 471—476. 1934a.

Arthur, J. — Journ. Arnold Arboret, Vol. 15: 263—265. 1934b.

Arthur, J. The Plant Rusts (Uredinales). New York. 1949. 446 pp.

Bäumler, J. A. Mycologische Notizen, II. — Oesterr. bot. Ztschr., Vol. 39: 289—291. 1889.

Rust fungi on plants of Compositae, collected in Turkestan by A. Regel, are described on page 290.

B. K. von. Meine Erfahrungen mit dem Getreiderost. — Balt. Wochenschr. Landw., Vol. 65: 333—334. 1907.

Błonski, F. Spis roślin skrytokwiatowych zebranykh w r. 1877 w Puszczy Bialowiezskiej. — Pamiętnik fizjograf., Vol. 8:76—119, Warsaw. 1888.

Five species of rust fungi are described on pp. 78—79.

Błonski, F. Spis roślin zarodnikowych zebranych lub zanotowanych w lecie w g. 1888 w puszczach Bialowiezskiej, Swislockiej i Ladzkiej. — Pamiętnik fizjograf., Vol. 9: 63—101, Warsaw. 1889.

Twenty-two species of rust fungi are described on pp. 69—70.

Błonski, F. Przyczynek do flory grzybow Polski (Symbolae ad floram mycologicam Poloniae). — Pamiętnik fizjograf, Vol. 14, Part 2, pp. 63—93, Warsaw. 1896.

The list includes 38 species of rust fungi partly collected in the areas bordering Belorussia, Lithuania and the Ukraine.

Bresadola, I. Fungi polonici a cl. viro B. Eichle lecti. — Ann. mycol., Vol. 1: 65—131. 1903.

The work includes a large number of species of fungi from areas bordering western Belorussia and the northwest Ukraine (formerly Siedlce and Lublin provinces).

Bretfeld. Vortrag über eine Anzahl von mikroskopischen Pilzen, welche als Krankheitserreger auf den Pflanzen des Riga'schen Strandes vielfach vorkommen. — Korr.-Bl. Naturf.-Ver., Vol. 31: 28, Riga. 1888.

Six species of rust fungi are reported.

Bubák, F. Einige neue und bekannte aussereuropäische Pilze. — Oesterr. bot. Ztschr., 50 (9) : 1—3. 1900. (Preprint).

A description of **Puccinia clintoniae udensis** Bubák sp. nov. (Table 9, Fig. 14—16) on **Clintonia udensis** Tr. et M., collected by V. L. Komarov in the Amur Area and published in "Fungi Rossiae" (Fasc. IV, No. 166) under the title: **Puccinia mesomegala** Berk. et Curt.

Bubák, F. Einige neue oder kritische Uromyces-Arten. — Sitzungsber. Böhm. Ges. Wiss., pp. 1—23, Prague. 1902.

The occurrence in Russia of **Uromyces limonii** (DC) Lev. **U. Komarovii** sp. nov. (in Manchuria), **U. mogianensis** sp. nov.

Buchheim, A. Zur Biologie von **Melampsora lini**. — Ber. Deutsch. bot. Ges., 33 (2) : 73—75. 1915.

Reports of the results obtained in experimental infections of several species of **Linum** with spores of **M. lini**.

Buchheim, A. Etude biologique de **Melampsora lini**. — Arch. sci. phys. et natur., Vol. 41: 149—154. 1916.

Report of the results obtained in experimental infections. The author separates 4 new forms apart from **M. liniperda** (Körn) Palm. on **Linum usitatissimum**.

Buchheim, A. Zur Biologie von **Uromyces pisi** (Pers.) Winter. — Vorläufige Mitteilung. Centrbl. Bakteriol., II Abt., 55 (21/24) : 507—508. 1922.

Buchheim, A. Beiträge zur Biologie der Uredinen. — Centrbl. Bakteriol., II Abt., Vol. 60: 528—536. 1924.

Uromyces primulae Fuck. and **U. pisi** (Pers.) Winter.

Buchholtz, P. Übersicht aller bis jetzt angetroffenen und beschriebenen Pilzarten des Moskauer Gouvernements. — Bull. Soc. imp. natur. Moscou, No. 1: 1—53. 1897b.

Ninety rust species are reported. Bibliography contains 23 references.

Buchholtz, F. Verzeichnis im Sommer 1896 in Michalowskoje (Gouvern. Moskau) gesammelter Pilze. -Bull. Soc. imp. natur. Moscou, No. 2 No. 2: 303—326. 1897c.

The list comprises 55 species of rust fungi, one species more than in the original Russian list (1897a) — Puccinia Peckiana Howe.

Buchholtz, F. Die Pilzparasiten des Sommer 1902 in der Umgegend von Riga. Nach den Beobachtungen von A. S. Bondarzew mitgeteilt. — Ztschr. Pflanzenkr., Vol. 13: 217—220. 1903.

See: A. S. Bondartsev, 1903.

Buchholtz, F. Die Pucciniaarten der Ostseeprovinzen Russlands. Vorstudie zu einer baltischen Pilzflora. — Arch. Naturkunde Liv-, Ehst- u. Kurlands, Vol. 13 (1) : 1—60. 1905a. (Offprint).

Indicated are 102 species; extensive annotations accompany many species. The collections of Vestergreen and other authors were used. The new species, Puccinia spicae-venti Buch. on Apera spica-venti (p. 19) and Puccinia rigensis Bucc. on Osterium palustra (p. 39), are described.

Buccholtz, F. Verzeichnis der bisher in den Ostseeprovinzien Russlands bekannt gewordenen Puccinia-Arten. — Ann. mycol., Vol. 3: 437—466. 1905b.

A slightly shortened reprint of the preceding work (1906a).

Buchholtz, F. Referate über die Vorträge betreffend die ostbaltischen Pilze. — Korr. -Bl. Naturf. -Ver., Riga, Vol. 69: 119. 1906.

About grain rusts.

Buchholtz, F. Uber den Getreiderost. — Balt. Wochenschr. Landw., Vol. 64: 12—15. 1906.

Buchholtz, F. Zur Rostfrage. — Balt. Wochenschr. Landw., Vol. 65: 425. 1907.

Buchholtz, F. Mykologische Notizen, 1. Sitzungsber. — Naturf. -Ges. Univ. Dorpat, Vol. 28: 10—11. 1921.

Aecidium corruscans (=Coleosporium Woroninii Tranz.) is reported.

Chelchowski, S. Spostrzezenia grzyboznawcze (Observationes mycologicae Poloniae). — Pamietnik fizjograf., Botanika and Zoologia, Vol. 17, Part III, pp. 3—38, Warsaw. 1902. (Preprint).

Twenty-six rust fungi are reported.

Constantineanu, L. C. Urédinées de Roumanie. — Ann. sci. Univ., 10 (3—4) : 344—460, Jassy. 1920.

Survey of rust fungi in Romania; 273 species on 592 host plants are reported; the following new species were established in part and published earlier: Puccinia artemisiae-arenariae (p. 316, Fig. 1), P. Desmazierii (p. 383, Fig. 2), P. elymicola (p. 387, Fig. 4), Uromyces frifolii-purpurei (p. 411, Fig. 5), U. viciae-craccae (p. 414, Fig. 6), U. Silenes-ponticae (p. 420, Fig. 7), Aecidium inulae-helenii (p. 453), Ae. erodii cicutarii (p. 457, for the first time !), Ae. asparagacearum (p. 457, for the first time !). There are species from Bessarabia and adjacent areas of Romania.

Dietel, P. Beschreibung eines neuen Phragmidiums. — Hedwigia, Vol. 29: 25—26. 1890.

Phragmidium papillatum sp. nov. from Siberia (formerly Yenisei Province).

Dietel, P. Über Puccinia conglomerata (Str.) und die auf Senecio und einigen verwandten Compositen vorkommenden Puccinien. — Hedwigia, Vol. 30: 291—297. 1891.

Species from the former Arkhangel'sk, Perm and Yenisei provinces.

Dietel, P. Einige neue Uredineen. — Hedwigia, Vol. 36: 297—299. 1897a.

Puccinia hutchinsiae sp. nov. (= P. aberrans Peck) and P. didymophysae sp. nov. from Turkestan are described on p. 299.

Dietel, P. Reihe Uredinales. — In: Engler und Prantl. Die natürlichen Pflanzenfamilien . . . , Vol. 6:24—81. 1897b.

Dietel, P. Betrachtungen über die Verteilung der Uredineen auf ihren Nährpflanzen. — Centrbl. Backteriol., Part II, Vol. 12: 218—234. 1904.

Dietel, P. Betrachtungen zur Systematik der Uredineen, I. Mycol. — Centrbl., 5 (2) : 65. 1914.

Dietrich, A. (Ditrikh, A.). Plantarum florae balticae cryptogamarum. — Centuriae I—IX, Revaliae. 1852—1857.

Rust fungi: Cent. I—58 numbers, II—41 numbers, III—2 numbers, IV — 25 numbers, V and VI — 19 numbers, VII and VIII — 26 numbers, IX — 29 numbers.

Dietrich, A. (Ditrikh, A.). Blicke in die Cryptogamenwelt der Ostseeprovinzen. — Arch. Naturkunde, Liv-, Ehst- u. Kurlands, zweite Serie, 1 (4) : 261—414, Dorpat. 1856.

Dietrich, A. (Ditrikh, A.). Blicke in die Cryptogamenwelt der Ostseeprovinzen. — Arch. Naturkunde Liv-, Ehst- u. Kurlands, Zweite serie, 1 (5) : 478 — 538, Dorpat. 1859.

Seventh-three rust species are reported.

Downar, N. (N. Dovnar). Enumeratio plantarum circa Mohileviam ad Borysthenem collectarum, tam sponte crescentium quam solo assuefactarum, spatio X milia passum. — Bull. Soc. imp. natur. Moscou, Vol. 1 : 165 — 189. 1871. Vol. 2: 599 — 607. 1862.

Puccinia graminis is included in the 8 fungal species reported.

Ehrenberg, S. G. Fungos a viro clarissimo Adalberto de Chamisso, etc. sub auspiciis Romanzoffianis in itinere circa terrarum globum collectos enumeravit novosque descripsit Dr. C. G. Ehrenberg; III. Nees v. Esenbeck. — Horae physicae Berolinensis, pp. 79 — 104. Bonnae. 1820. With 20 tables and 13 figures.

The rust Caeoma (Uredo interstitiale Schl. (= Gymnoconia interstitialis (Schl.) Lagerh.) on Rubus arcticus L. is described and illustrated by Schlechtendal on p. 96; "Caeoma (Uredo) rosae?" (Phragmidium rosae (Barcl.) Tranz.) on Rosa is mentioned. Both fungi were collected in Kamchatka in 1816. A. de Chamisso was botanist to the Russian ship "Rurik," commanded by Otto von Kotzebue, on its voyage round the world.

Eichler, B. Przyczynek do flory mycologicznej okolic Międzyrzeca. Rdzawnikowate (Uredineae). — Pamiętnik fizjograf., Vol. 11: 85 — 91, Warsaw. 1891.

The report includes: Uromyces — 16 species, Puccinia — 46 species, Triphragmium ulmariae Schum., Phragmidium — 7 species, Gymnosporangium — 2 species, Melampsora — 14 species, Coleosporium — 4 species, Chrysomyxa ledi Alb. et Schw., Cronartium — 2 species, Uredo — 2 species, Caeoma — 2 species, and Aecidium — 1 species, totalling 96 species. The fungi were collected in Polish regions bordering on Belorussia and the Ukraine.

Eichler, B. Materjaly do flory grzybow okolic Miedzyrzeca. — Pamiętnik fizjograf., Vol. 16: 157 — 206, Warsaw. 1900.

The report comprises 555 species of fungi, predominantly basidiomycetes.

Eichler, B. Przyczynek do flory grzybow okolic Miedzyrzeca. — Pamiętnik fizjograf., Vol. 17: 39 — 67, Warsaw. 1902.

Ten species of rust fungi are reported from the former Siedlce Province.

Eichler, B. Drugi przyczynek do flory grzybów okolic Międzyrzeca. — Pamiętnik fizjograf., Vol. 18: 1 — 31, Warsaw. 1904.

A list of 303 species of fungi including 2 rusts is presented.

Fedtschenko, Olga et Boris. Matériaux pour la flore de la Crimée. — Bull. Herb. Boissier, seconde série, V, pp. 621—638. 1905.

Sixteen fungi species determined by Jaczewski, including 9 rusts, are recorded.

Ferle, F. Die erste und zweite Rostenquete in Kurland. — Balt. Wochenschr. Landw., Vol. 65: 165—170, 401. 1907a. Vol. 66: 201—205. 1908a.

Ferle, F. Die erste und zweite Rostenquete in Livland. — Balt. Wochenschr. Landw., Vol. 65: 385—388. 1907b. Vol. 66: 257—258. 1908b.

Ferle, F. Verzeichnis parasitischer Pilze, soweit dieselben in den Jahren 1907—1912 vom Verf. in Liv- und Kurland gefunden worden sind. — Korr. Bl. Naturf. -Ver., pp. 103—106, Riga. 1916.

Fifth-eight species of rust fungi are presented that are parasitic on 87 host plants without accurate indications of their habitat.

Goldbach, C. L. (Gold'bakh, K.). Catalog der moskowischen Flora. — Flora oder Regensb. bot. Zeitung, zweite Beilage, pp. 17—24. 1820.

Eight species of rust fungi without indications as to their hosts and habitat are listed on p. 24.

Granit, A. W. Tallkräftan och dess härjningar. — Finska Forstförenningens Meddelanden, Vol. 14: 101—110. 1896.

Rust fungi from Karelia.

Hennings, P. Fungi Turkestanici. — Hedwigia, Vol. 37:290—292. 1898.

Some of the 7 rust species were earlier reported by Kuntze — from Omsk (1), the Amur Region (1), the former Transcaspian Region and Turkestan (5).

Hennings, P. Beitrag zur Pilzflora des Gouvernements Moskau. — Hedwigia, Vol. 62: 108—118. 1903.

The fungi described were collected in the environs of the village of Mikhailovskoe in Podolsk County, former Moscow Province, and obtained from the Sheremetev Museum. Of the 117 species listed, 4 are rusts.

Hennings, P. Zweiter Beitrag zur Pilzflora des Gouvernement Moskau. — Hedwigia, Vol. 63: 66—73. 1904.

Three rust species are reported.

Hennings, P. Dritter Beitrag zur Pilzflora des Gouvernements Moskau. — Hedwigia, Vol. 65: 22—33. 1905.

Of the 174 species of fungi listed, 17 are Uredineae.

Heyden, K. K. Zur Pilzflora des Gouvernements Moskau. — Hedwigia, Vol. 38: 269—273. 1899.

The list includes 31 species of rust fungi.

Hiratsuka, N. A Provisional List of the Melampsoraceae of Saghalien. — Bot. Mag., 52 (493): 26—32. 1928.

The list comprises 28 species of rust fungi.

Hiratsuka, N. Thekopsora of Japan. — Bot. Mag., 63 (505): 12—22. 1929a.

Fungi of the Kuril Islands and Sakhalin are reported.

Hiratsuka, N. Notes on the Melampsoraceae Collected in the So-Called "Tundra" near Shisuka, S. Saghalien. — Journ. Soc. Agric. Forestr. Sapporo, Vol. 21: 56—63. 1929b.

Hiratsuka, N. Additional Notes on the Melampsoraceae of Saghalien. — Trans. Sapporo Nat. Hist. Soc., 10 (2): 119—121. 1929c.

Ten species of rust fungi are reported.

Hiratsuka, N. Pucciniastrum of Japan (Notes on the Melampsoraceae of Japan, III). — Bot. Mag., 66 (521): 261—284. 1930a.

The fungi described were collected in Sakhalin and the Kuril Islands.

Hiratsuka, N. Erster Beitrag zur Uredineen-Flora von Südsachalin. — Mem. Tottori Agric. Coll., Vol. 1: 63—98. 1930b.

The list comprises 106 species, indicating their host plants and site and date of collection. The bibliography on rust fungi in Sakhalin contains 14 references (from 1906 to 1930).

Hiratsuka, N. Zweiter Beitrag zur Uredineen-Flora von Südsachalin. — Trans. Tottori Soc. Agric. Sci., Vol. 2, Part 3, pp. 233—245. 1931.

Continuation of preceding list (1930b); comprises 53 species (Nos. 107—159).

Hiratsuka, N. Studies on Uromyces fabae and its Related Species. — Japan. Journal Botany, 7 (3): 329—379. 1933.

Morphological studies and experimental infections; Uromyces fabae, U. orobi, U. ervi were studied. U. fabae is reported from Sakhalin.

Hiratsuka, N. A contribution to the Knowledge of the Rust-Flora in the Alpine Regions of High Mountains in Japan. — Mem. Tottori Agric. Coll., 3 (2): 125—247. 1935.

Eighty-three species of rust fungi were discovered in the Alpine zone of the Japanese Islands and in Sakhalin. The number of microforms is comparatively higher in the Alpine zone than in

the foothills; in Japan their number is increasingly higher in the south-north direction. Among the new species described are the following: Gymnosporangium nipponicum Jamada on Juniperus chinensis L. var. sargentii Henry (p. 143), Uromyces yatsudatakense Hirats. on Hedisarum esculentum Led. (p. 147), Puccinia iwateyamensis Hirats. on Pleuropteropyrum (Polygonium) Nakai Hara (p. 140; Fig. 1b on p. 142), Puccinia Togashiana Hirats. on Thalictrum tuberiferum Maxim. (p. 141; Fig. 1a on p. 142). Bibliography contains 81 references; there is an alphabetical index of host plants and fungi and a map of the Japanese archipelago.

Hiratsuka, N. Materials for a Rust-Flora of Manchouko, I. — Trans. Sapporo Nat. Hist. Soc., Vol. 16, Part 4, pp. 193—208. 1941.

The list includes 93 species from areas bordering the USSR; many of the species are common in eastern Siberia and the Soviet Far East.

Hisinger, E. Aecidium conorum — Abietis Reess funnen in Finland redan ar 1864. — Botaniska Notiser, p. 74. 1876a.

Hisinger, E. Peridermium pini (Willd.) Pers. α corticola dödande Pinus strobus. — Botaniska Notiser, p. 75. 1876b.

Hisinger, E. Puccinia malvacearum Mont. Lumnien till Finland 1890. — Meddel. Soc. fauna et flora Fennica, Vol. 16: 187—189. 1891.

Hutchinson, J. The Families of Flowering Plants. I. Dicotyledones, pp. 8—9. 1926.

Ivanov, K. S. Die parasitischen Pilze im Gouvernement Tiflis (Kaukasus). — Ztschr. Pflanzenkr., Vol. 9: 356—358. 1899.

Sixteen species of rust fungi are reported.

Jaczewski, A. Catalogue des champignons recueillis en Russie en 1894 à Rylkovo, gouvernement de Smolensk. — Bul. Soc. mycol. France, Vol. 9: 212—222. 1893.

The list comprises 177 species of fungi including 26 rusts.

Jaczewski, A. Note sur le Puccinia Peckiana Howe. — Bull. Herb. Boissier, 11 (2): 142—144. 1894. With 1 plate.

Jaczewski, A. III série de matériaux pour la flore mycologique du gouvernement de Smolensk. — Bull. Soc. imp. natur., No. 1: 65—94, Moscou. 1896.

Rust fungi Nos. 420—462.

Jaczewski, A. IV série de matériaux pour la flore mycologique du gouvernement de Smolensk. — Bull. Soc. imp. natur., No. 3: 421—436, Moscou. 1897a.

Ten species of rust fungi are listed.

Jaczewski, A. Neue und wenig bekannte Uredineen aus dem Gebiete des europäischen und asiatischen Russlands. Decas prima. — Hedwigia, Vol. 39: 129—134. 1900.

Ten species of rust fungi including 6 new species.

Jørstad, I. Chytridineae, Ustilagineae and Uredineae from Novaya Zemlya. — Report of the Scientific Results of the Norwegian Expedition to Novaya Zemlya 1921, No. 18:1—12, Christiania. 1923. (Preprint).

Species reported are: **Puccinia cardamis bellidifoliae** Diet. on **Cardamine bellidifolia** L., **P. eutremae** Lindr. on **Eutrema Edwardsii** R. Br., **P. drabae** Rud. on **Draba nivalis** Lil., **P. saxifragae** Schl. on **Saxifraga nivalis** L., **P. Lyndei** Jorst. sp. (Fig. 1) on **Saxifraga flagellaris** Willd., **P. novazemliae** Jorst. sp. nov. (Fig. 2) on **Campanula uniflora** L., **Melampsora arctica** Rostr. (I) on **Saxifraga groenlandica** L. and **S. oppositifolia** L. (II—III) on **Salix polaris** Wbg., **S. rotundifolia** Trautv., **S. reptans** Rupr., **S. arctica** Pall. and on their hybrids.

Jørstad, I. Notes on Uredineae. — Nyt. Mag. Naturvidenskaberne, Vol. 70: 325—408. 1932.

The material used in this work includes herbarium specimens collected in the Karelian Isthmus, the Komi ASSR, Siberia, Novaya Zemlya, Kamchatka, Sakhalin and other regions of the USSR. Alphabetical index plus 17 illustrations.

Jørstad, I. Parasitic Fungi from Various Parts. — Nyt. Mag. Botanik, Vol. 1: 89—106. 1952.

Jundzill, J. Opisanie roslin w Litwie, na Wolyniu, Podolu i Ukrainie dziko rosnacych jako i oswojonych. Vilna. 1830. XII + 583 p.

Kalchbrenner, C. and F. Thümen de. Fungorum in itinere Mongolica a clar. G. N. Potanin et in China boreali a cl. Dr. Bretschneider lectorum enumeratio et descriptio. — Bull. Acad. imp. Sci. St.-Petersb., Vol. 28: 135—142. 1881.

Aecidium oxytropidis Thüm. and **Uromyces hedysari** Fuck. are reported from northern Mongolia.

Karsten, P. A. Symbolae ad mycologiam fennicam. (I) V. Peronosporei, Aecidiei et Ustilaginei e regione Musialensi hucusque cogniti. — Notiser ur sällsk. fauna et flora Fennica förhandl., XI Häft, Ny serie, Häft VIII, pp. 211—268, Helsinki. 1871.

Sixty-nine numbers of rust fungi are listed.

Karsten, P. A. Symbolae ad mycologiam fennicam. — Meddel. Soc. fauna et flora Fennica, (III) XI, Häft 1, p. 59. 1876. (IV) XIII, Ibid., Häft 2, p. 179. 1878. (IV) XIII, Ibid., p. 183. VI. Ibid., Häft 5, p. 46. 1880.

VII, Ibid., Häft 6, p. 6. 1881. IX, Ibid., Häft 9, p. 56. 1882. XIII, Ibid., Häft 11, p. 5. 1885. XXI, Ibid., Häft 14, pp. 103—110. 1888. XXIII, Ibid., Häft 16, p. 9. 1888. XXVIII, Ibid., Häft 16, p. 45. 1888. XXIX, Ibid., Häft 16, p. 105. 1889. XXX, Ibid., Häft 18, p. 68. 1891. XXXII, Acta Soc. fauna et flora Fennica, 9 (1): 1—11. 1893. XXXIII, Ibid., 11 (5): 1—4. 1895.

Rust fungi from Finland and the northwestern regions of the USSR are reported.

Karsten, P. A. Enumeratio fungorum et myxomycetum in Lapponia orientali aestate 1861 lectorum. — Notiser ur sälsk. fauna et flora fennica förhandl. VIII Häft, Ny Serie, Häft V, pp. 193—224, Helsinki. 1882.

Of the 425 fungi reported from Lapland (including Kola Gulf) and Finland, Nos. 359 — 391 are rusts.

Karsten, P. A. Finlands rost- och brandsvampar (Hypodermii), i korthet beskrifna. — Bidrag till kannedom af Finnlands natur och folk, Vol. Vol. 39: I—VI, 1—118. 1884.

No great importance can be attached to the host plants indicated since they have obviously been taken from Winter.

Karsten, P. A. Fragmenta mycologica, XLIV. — Hedwigia, Vol. 35: 43—49. 1896.

Rust fungi from regions of the USSR bordering on Finland are listed on p. 46.

Karsten, P. A. Fungi novi, paucis exceptis, in Sibiria a clarissima O. A. F. Loennbohm collecti. — Öfversigt af Finska Vetenskaps-Soc., Förhandl. 46 (11) : 1—9. (1903—1904) 1904.

Descriptions of Uromyces sii-latifolii sp. nov. from Samara, U. saussureae sp. nov. from Kurgan-Omsk (?), Puccinia melasmioides Tranz. on Aquilegia viridiflora from Baikal and Coleosporium actaeae sp. nov. from Baikal can be found on p. 6.

Karsten, P. A. Fungi novi nonnulis exceptis in Fennia lecti. — Acta Soc. fauna et flora Fennica, 27 (4): 1—16. 1905.

On p. 16, Karsten writes: "Puccinia melasmioides Tranzsch. var. Karst. l. c. (Fungi novi in Sibiria lecti) p. 6 eadem estae Puccinia Haleniae Arth. et Holw. in Halenia sibirica crescens." Karsten's meaning here is not clear. He probably thought that the host plant of the fungus presented (P. melasmioides var. Karst.) was not correctly determined, i. e., that it was Halenia sibirica, not Aquilegia viridiflora.

Kawai, K. and H. Otami. A Provisional List of Fungi Collected in Southern Saghalien. — Trans. Sapporo Nat. Hist. Soc., Vol. 11, Part 4, pp. 227—242. 1931.

The list comprises 98 species of rust fungi with indications of their hosts and site and date of collection.

Komarov, V. Ueber Pucciniostele Clarkiana (Barkl.) Tranz. et Kom. — Hedwigia, Vol. 39: 121—123. 1900a.

Komarov, V. Diagnosen neuer Arten und Formen, sowie kritische Bemerkungen zu bekannten Arten, welche in Jaczewski, Komarov, Tranzschel "Fungi Rossiae exsiccati" fasc. VI and VII (1899) herausgegeben worden sind. — Hedwigia, Vol. 39: 123—129. 1900b.

Comprises diagnoses of Puccinia dioscoreae, Coleosporium perillae, C. phellodendri, Pucciniastrum coryli, Triphragmium clavellosum Berk. f. asiatica, Uredinopsis adianti, Pucciniostele Clarkiana, P. potentillae, Thekopsora rubiae.

Krupa, J. Zapiski mykologiczne przewaznie z okolic Lwowa i z Tatr. — Kosmos, Vol. 11: 370—399, Lwow. 1886.

The list cornprists rust fungi under Nos. 66—132.

Krupa, J. Zapiski mykologiczne z okolic Lwowa i z Podtatrza. Materyjaly do fizjografii krajowey. — Sprawozd. Komisji fizjograf. Akad. Umiejętnosci, Vol. 22: 12—47, Krakov. 1888.

The list of rust fungi, collected mainly in the environs of Lwow, include: Uromyces 16, Puccinia 46, Triphragmium 2, Phragmidium 47, Gymnosporangium 3, Melampsora 13, Coleosporium 4, Chrysomyxa pirolatum Koern., Uredo 2 and Aecidium 5. The host plants and sites of collection are given.

Kruszýnski, R. Spis grzybów pasorzytniczych zebranykh w latach 1930—1931 w okolicach Lidy. — Prace Towarzystwa Przyjaciól Nauk w Wilnie, Wydz. nauk matem. i przyrodn., Vol. 8. Prace Zakładu Systematyki Roslin i Ogrodu Botanicznego Univ. St. Batorego w Wilnie, No. 6: 1—16. 1934.

The list comprises 69 species of rust fungi (Nos. 22—90). The host plants, collection sites, stage of development and date of collection are included.

Kuntze, Otto. Plantae Orientali-Rossicae. — Trudy Imperatorskogo Sankt Peterburgskogo Botanicheskogo Sada, 10(1): 135—262. 1887.

Twenty species of fungi, determined by Winter and Hennings, are described on pp. 261—262. Uredineae — 9 species from the former Petersburg and Moscow provinces, from southern Russia, the Caucasus and Transbaikalia.

Kursanow, L. Zur Sexualität der Rostpilze. — Ztschr. Botanik, 11 (2): 81—93. 1910a.

Kursanow, L. Ueber die Peridienentwicklung im Aecidium. — Ber. Deutsch. bot. Ges., 32 (5): 317—327. 1914.

Observation on the development of aecia of Puccinia graminis Pers., Aecidium punctatum Pers., Gymnosporangium tremelloides Hart., Peridermium pini (Wild.) Lev., Endophyllum sempervivi Lev. and others.

Lepik, E. Uber die geographische Verbreitung von Cronartium rubicola. — Mitt. Phytopathol. Versuchsstat. Univ. Tartu, No. 21: 1—7. 1934.

Lepik, E. Einige bemerkenswerte Uredineenfunge aus Estland. — Ann. mycol., Vol. 34: 435—441. 1936.

Lepik, E. The Distribution of Pine-Rusts in Estonia. — Bull. Phytopathol. Exper. Sta. Univ. Tartu, No. 42: 177—196. 1937.

The list includes 2 species of Cronartium, 7 species of Coleosporium, Melampsora pinitorqua Rostr. and Peridermium pini (Willd.) Kleb.

Lepik, E. Beiträge zur Nomenklatur des ostbaltischen Pilzflora. III. Revision der "Plantarum florae Balticae cryptogamarum." Collegit et edidit A. H. Dietrich, centuria II, Revaliae, MDCCCLIII. — Tartu Ulikooli Taimehaiguste-katsejaama teated, No. 47: 226—242. 1938.

Lepik, E. Contributions to the Fungus Flora of Estonia, I. — Tartu Ulikooli Taimehaiguste-katsejaama teated, No. 55: 1—33. 1939a. (Preprint). (Bull. Phytopathol. Exper. Sta. Univ. Tartu).

The list includes 30 species of rust fungi, including Uromyces lupinicola Bubak.

Lepik, E. Beiträge zur Nomenklatur der ostbaltischen Pilzflora. IV. Revision der "Plantarum florae Balticae cryptogamarum." Collegit et edidit A. H. Dietrich, Uredinales und Ustilaginales aus centurien I—IX, Revaliae MDCCCLII—MDCCCLVII. — Ibid., No. 56: 1—46. 1939b.

Critical review of the nomenclature of all 900 rust and smut fungi.

Lepik, E. Beiträge zur Nomenklatur der ostbaltischen Pilzflora. V. Eine alte Pilzsammlung von A. H. Dietrich. — Ibid., No. 56: 47—62. 1939c. (Ann. Soc. Rebus Nat. in kestig. Tartu, Vol. 65. 1938).

Critical review of the collection; more than 50 species of rust fungi listed.

Lepik, E. Beiträge zur Nomenklatur der ostbaltischen Pilzflora. VI. Eine Pilzkollektion von G. Pahnsch. — Ibid., No. 56: 62 — 66. 1939d.

In the critical review of this collection, 11 species of rust fungi are presented.

Lepik, E. Kastre-Peravalla locduskaitse reservaadi seenestik. — Ibid., No. 58: 56 — 91. 1940.

List of fungi from the Tartu University Experimental Forestry Station in Kastre-Peravala. The 54 species of rust fungi indicated were collected from 83 species of plant hosts.

Léveillé, J. H. Énumération des plantes recueillies en Tauride. In: A. de Démidoff, Voyage dans la Russie méridionale et la Crimée, Vol. 2: 9 — 237. 1842.

List of algae, mosses, lichens and fungi; rust fungi number 25.

Liboschitz, J. Enumeratio fungorum quos in nonnulis provinciis Imperii Ruthenici observavit Josephus Liboschitz, Doctor medicinae, fasc. I. — Mem. Soc. natur. Moscou, Vol. 5: 73 — 83. 1817. Tab. IV — VII.

Five species of rust fungi are described and the names of 101 fungi are given, including 9 Aecidium. The names of the authors, site of collection and habitat are not indicated.

Lind, J. Bemerkungen über einige parasitische Pilze aus Russland. — Ann. mycol., Vol. 6: 96 — 104. 1908.

Critical review and revision of N. S. Sredinsky's "Herbarium cryptogamicum rossicum (Sect. quarte: Fungi, Nos. 1 — 50). In addition, rust fungi are indicated on plants that appear in "Herbarium florae Rossicae, and Museo bot. Acad. imp. Sci. Petropolitan. editum." About 40 species of rust fungi are presented from the Caucasus, the Crimea, the environs of Odessa and St. Petersburg.

Lindroth, J. I. Rostsvampar. — Meddel. Soc. fauna et flora Fennica, Vol. 23: 48, 198. 1898.

Four species of rust fungi are presented from the former Arkhangel'sk Province and from Finland.

Lindroth, J. I. Beiträge zur Pilzflora Finlands. Lisätietoja Suomen sienistä. — Acta Soc. fauna et flora Fennica, 16 (3): 1 — 15. 1899. (Preprint).

Seventy species of rust fungi, including those collected in the Karelian Isthmus and other regions of the USSR.

Lindroth, J. I. Om Aecidium Trientalis Transchz. — Botaniska Notizer, pp. 193 — 200. 1900a.

Lindroth, J. I. Mycologische Notizen. — Botaniska Notizer, pp. 241 — 255. 1900b.

The following new species are described: Aecidium sanguinolentum (Karelia and others; p. 241), Cronartium pedicularis (Karelia; p. 246), Puccinia crepidis-sibiricae (Karelia, Arkhangel'sk Region, etc.; p. 247), Aecidium sceptri (Karelia; p. 250).

Lindroth, J. I. Mycologische Mitteilungen, I — IV. — Acta Soc. fauna et flora Fennica, 20 (9): 1 — 29. 1901a. (Preprint). With 8 illustrations.

Critical review of some species of rust fungi, among them **Puccinia kamtschatkae** Anders., **P. minussensis** Thüm. The new species Uromyces mulgedii Lindr. on Mulgedium tataricum from Tibet (pp. 18 — 19) are described.

Lindroth, J. I. Uredineae novae. — Meddel fr. Stockholms Högskolas botaniska Institut, Vol. 4: 1 — 8. 1901b. (Preprint).

The following new species from different regions of the USSR are described: Aecidium Thysselini (p. 1), A. Selini (p. 1), Uromyces **Hippomartini** (p. 1), **Puccinia Prescotti** (p. 2), **P. libanotidis** (p. 2), **P. elliptica** (p. 3), **P. psoraderma** (p. 5), **P. pallidefaciens** (p. 7), Aecidium Tranzschelianum (p. 8), and also P. spilogena (from northern Iran).

Lindroth, J. I. Die Umbelliferen-Uredineen. — Acta Soc. fauna et flora Fennica, 22 (1): 1 — 224. 1902a.

A monograph reviewing rust fungi on **Umbelliferae**. Many species are from the USSR. The following new species are described: **Puccinia retifera** (p. 20), **P. laserpitii** (p. 35), **P. sphalerocondra** (p. 63), **P. phymatospora** (p. 68), **P. microsphineta** (p. 74), **P. aphanicondra** (p. 86), **P. leioderma** (p. 110), **Uromyces ferulaginis** (p. 148), **U. pteroclaenae** (p. 148) and others. The author divides the rust fungi growing on Umbelliferae into three groups, according to the structure of the teliospore wall: network structure (Reticulatae), warted (Psorodermae) and smooth with thickening at the apex of the urediospore wall (Bullatae). These three groups are subdivided. Both divisions are shown in tables. There is an extensive bibliography and an alphabetical index of the fungi and hosts. There are no illustrations.

Lindroth, J. I. Mycologische Mitteilungen, V — X. — Acta Soc. fauna et flora Fennica, 22 (3): 1 — 20. 1902b.

Teliospores structure of **Chrysomyxa cassandrae** (Gobi) Tranz.; diagnoses of new rust species on **Cruciferae**; diagnoses of two species of rust fungi on **Crepis**; rusts on **Rubiaceae**; **Melampsora hirculi** sp. nov.

Lindroth, J. I. Mycologische Mitteilungen, XI—XV. — Acta Soc. fauna et flora Fennica, 26 (5): 1—18. 1904.

Critical review of some species of rust fungi; new or rare species.

Liro (Lindroth), J. I. Kulturversuche mit finnischen Rostpilzen, I. — Acta soc. fauna et flora Fennica, 29 (6): 1—25. 1906.

Liro, J. I. Kulturversuche mit finnischen Rostpilzen, II. — Acta Soc. fauna et flora Fennica, 29 (7): 1—58. 1907.

Liro, J. I. Uredineae fennicae. Finlands Rostsvampar. Helsinki. 1908. VII + 642 p. Species from Karelia and Petersburg Province are described.

Liro, J. I. Mycotheca Fennica. Helsinki. 1934. 97 p.

Comprises Nos. 1—300; some of the rust species are from the Karelian Isthmus and other regions in the northwestern part of the USSR. A map of these regions accompanies the text.

Magnus, P. Fungi, pars II. Ein Beitrag zur Kenntnis der Pilze des Orients. — In J. Bornmüller. Iter persico-turcicum 1892—93. Verhandl. K. K. Zool. bot. Ges., Vol. 69: 87—103, Vienna. 1899.

Rust fungi of regions adjacent to the USSR are described. Excellent illustrations on two separate plates.

Magnus, P. Uber die richtige Benennung einiger Uredineen nebst historischer Mittheilung über Heinrich von Martiums, Prodromus florae Mosquaensis. — Österreich. bot. Ztschr., Vol. 52: 428—432, 490—492. 1902.

Magnus, P. Fungi. Ein weiterer Beitrag zur Kenntnis der Pilze des Orients. — In: J. Bornmüller. Iter anatolicum tertium 1899. Bull. Herb. Boissier, seconde série, 3 (7): 573—587. 1903.

On p. 578, under Puccinia centaureae DC, the following is described: "on Centaurea phyllocephala Boiss. Russian Armenia, Nakhichevan District, June 23, 1901, Fomin Collection."

Maire, R. La biologie des Uredinales. — Progr. Rei bot., Vol. 4: 11.5. 1911.

Martius, Henricus de. Prodromus florae Mosquaensis. Editio altera. Lipsiae. 1817. XVI + 288 p.

Mayor, Eug. Mélanges mycologiques. — Bull. Soc. Neuchât. sci. natur., Vol. 61: 97—105. 1915 (?).

List of rust fungi found on plants received from the Herbarium of the Botanical Institute of Neuchâtel University. Among the rusts listed from different countries (pp. 98—99), there are 9 species from the environs of Novocherkassk, collected in 1910—1911.

Melamedaite, C. Lietuvos parazitiniai grybai, surinkti 1931 m. — Scripta Horti. bot. Univ. Vytauti Magni, II, (Matematikos-Gamtos Fakulteto Darbai, VII, 1931 —1932), pp. 73—76. 1932.

Thirty species of fungi, including 10 rusts, are listed.

Minkevičius, A. Lietuvos rūdžiu (Uredinales) floras metmenys. Grundzuege der Uredineen-Flora Litauens. — Mém. Facult. sci. Univ. Vytautas I. Grand, 11 (4): 333—450. 1937.

The review deals with 176 species of rust fungi recorded on 305 plant hosts. The fungi are listed in alphabetical order. Extensive annotations accompany many of the species listed; biometrically-processed data of the spore are given for several species, with special reference to the plurivorous fungi. Bibliography contains 28 references; alphabetical index.

Minkevičius, A. Veimitrudes, Cronartium ribicola Dietrich, iššiplatiñimo Lietuvoje, jos žalingumo ir jos ziemojimo klausimu. — V. D. U. Matem.-Gamtos Fak. Darbai, XIII (Scripta Horti Botanici Universitatis Vytauti Magni), Vol. 6: 95—133, Kaunas. 1939.

Studies on Cronartium ribicola, conducted in the Kaunas Botanical Gardens, are reported. The distribution of fungus in Lithuania is described.

Muszynski, J. Masowe wzstapienie rdzykozlikowej Puccinia commutata Sydow na hodowanej Valeriana officinalis L. — Acta Soc. bot. Poloniae, Vol. 7: 89—92, Warsaw. 1931.

Puccinia commutata Syd. on Valeriana officinalis in Vilna is reported.

Namysłowski, B. Zapiski grzyboznawcze z Krakowa, Gorlic i Czarnej Hory. Hory. — Sprawozd. Komisji fizjograf. Akad. Umiejętności w Krakowie, Vol. 63: 1—30. 1909a.

More than 50 species of rust fungi reported.

Namysłowski, B. Mycotheca polonica, fasc. IV. — Kosmos, Vol. 35: 1007—1012, Lwow. 1910a.

Fifteen species of rust fungi (Nos. 172—186) from the former Vitebsk and Mogilev provinces.

Naumoff, N. Matériaux pour la flore mycologique d. l. Russie, Fungi ussurienses, I. — Bull. Soc. mycol. France, 30 (1): 1—20. 1914b.

The list includes 20 species of rust fungi collected in the Far East. The new genus Triphragmiopsis and new species T. jeffersoniae on Jeffersonia dubia are described.

Namysłowski, B. Zapiski z wycieczek mykologicznych odbytych w g. 1902. — Kosmos, Vol. 35: 1025—1030, Lwow. 1910b.

Twenty-four species of rust fungi reported.

Namysłowski, B. Prodromus Uredinearum Galiciae et Bukovinae. Rdze Galicji i Bukowiny. — Sprawozd. Komisji fizjograf. Akad. Umiejętnosci w Krakowie, Vol. 65:65—146. 1911a.

The survey comprises 273 species; the hosts, sites of collection and spore form are indicated. Bibliography includes 17 references. There is an index of fungi according to the individual county, an alphabetical index of host plants, and a distribution map.

Namysłowski, B. Przyczynek do znajomości rdzy. — Kosmos, Vol. 36:293—299, Lwow. 1911b.

Uromyces carpathicus Namysl. (p. 293, Fig. 1—5) on Geranium phacum and Aecidium aposoeridis Namysl. ad interim (p. 295) on Aposeeris foetida of the Western Ukraine are described.

Namysłowski, B. Śluzowe i grzyby Galicji i Bukowiny — Pamiętnik fizjograf., Vol. 22, dzial IV, Botanika, pp. 1—151, Warsaw. 1914.

The 1793 species of fungi and myxomycetes listed are based on data obtained from the author's research and other sources. Rust fungi Nos. 542—817. There are Carpathian forms unknown in the more northern parts of the Ukraine.

Nylander, W. and T. Sälan. Herbarium Musci fennici. Helsinki. 1859. 118 p.

Among the 358 fungi listed some are rusts. A geographical map is included.

Oudemans, C. A. J. A. Contributions à la flore mycologique de Nowaja Semlja. — Versl. en Mededeel. Konink. Akad. Wetensch., Afd. Natuurkunde, Z Reeks. Tweede Deel, pp. 146—162, Amsterdam. 1886.

Puccinia dentariae Fuck. (= P. Oudemansii Tranz.) on Mathiola nudicaulis Trautv., collected in Novaya Zemlya by M. Weber, is reported (p. 158).

Petrak, F. Beiträge zur Pilzflora Sudost-Galiziens und der Zentralkarpathen. — Hedwigia, Vol. 65:179—330. 1925.

The work lists 118 fungi, including rusts (pp. 184—193), the host plants, date of collection, and other information. The bibliography contains 35 references.

Picbauer, R. Třetí příspěvek ku květeně Moravskýkh hub. — Vestnik přírodovědeckého v Prostějově za rok 1913, Vol. 16:1—18. 1913.

The site of collection and host plants of 36 species of rust fungi are reported.

Picbauer, R. Addenda ad floram Cechoslovkiae mycologicam, III. — Sbornik Vysoké školy zemědělské v Brne, ČSR, Fak. Lesnická Part 7, pp. 1—25. 1927. (Preprint). (Bull. Ecole super. agronom. Brno).

The list comprises rust fungi from the Transcarpathian Ukraine.

Poeverlein, H. Die Gesamtverbreitung der Uropyxis sanguinea in Europa. — Ann. mycol., 38 (5—6):421—426. 1930.

Poeverlein, H. Puccinia Antirrhini Dietel et Holway, ein neuer Eindringling aus Nordamerika. — Ann. mycol., 33 (1—2):104—107. 1935.

Poirault, G. and P. Hariot. Une nouvelle Urédinée des Crucifères. — Journ. botanique, p. 272. 1891.

Caeoma Moroti sp. nov. on Cardamine sp. is reported. According to Tranzschel, the fungus proved to be Coleosporium campanulae on Campanula rotundifolia (collected in the former Petersburg Province).

Rabenhorst, L. Übersicht der von Prof. Dr. Haussknecht im Orient gesammelten Kryptogamen. — Hedwigia, 11 (2):17—27, 177—180. 1871.

Fungi and lichens are reported, mainly from Iran, but also from Transcaucasia. There are more than 20 species of Uredinales.

Raciborski, M. Materjały do flory grzybów Polski. I. Rdze (Uredineae). — (Uredineae). — Sprawozd. Komisji fizjograf. Akad. Umiejętności w Krakowie, Vol. 21:49—64. 1888.

The 123 names of rust fungi are reported from the vicinity of Krakow, Galicia and Poles'ye.

Raciborski, M. Über einige Pilze aus Süd-Russland. — Hedwigia, Vol. 30:243—246. 1891.

Twenty-two species of rust fungi collected in the Crimea and the Caucasus.

Raciborski, M. Mycotheca Polonica (fasc. II and III, Nos. 51—150). — Kosmos, Vol. 35:768—780, Lwow. 1910.

Thirty-four (Nos. 117—150) species of rust fungi, collected mainly in the former Lwow County, Podolia and Bukovina.

Rauhala, A. Aecidium ruostelöytojä. — Karstenia, No. 2:46. 1953.

Aecidium ligulariae Thüm. in the Karelian ASSR.

Ricker, P. L. Notes on Fungi. II. With New Species from Various Localities. — Journ. Mycology, Vol. 11:111—115. 1905.

On p. 114 there is a description of Puccinia aeluropi Ricker sp. nov. on Aeluropus littoralis Parl., collected by Frick in the Caucasus.

Rostrup, E. Lieutenant Olufsen's Second Pamir-Expedition. Plants Collected in Asia-Media and Persia by Ove Paulsen. V. Fungi. — Bot. Tidsskr., Vol. 28:215—218. 1907.

New species: Aecidium spinaciae on leaves of Spinacia tetrandra Stev., Aecidium tataricum (=Ae. ixiolirionis Kom.) on Ixiolirion tataricum Schult.

Rouppert, K. Zapiski grzyboznawcze z Galicji. — Sprawozd. Komisji fizjograf. Akad. Umiejętności w Krakowie, Vol. 63:31—38. 1909.

The list comprises 14 species of rust fungi from Galicia.

Rouppert, K. Puccinia Zopfii Winter w Polsce. — Kosmos, Vol. 36: 311—313, Lwow. 1911a.

Distribution of Puccinia Zopfii in Poland, including the Western Ukraine.

Rouppert, K. Zapiski grzyboznawcze z Ciechocinka i innych stron Królewstwa Polskiego. — Kosmos, Vol. 36:740—746. 1911b.

Fifteen species of rust fungi are reported.

Rouppert, K. Przyczynek do znamjomości grzybow Galicji i Bukowiny. — Kosmos, Vol. 36:936—944, Lwow. 1911c.

Rouppert, K. Róza pęcherzýkowata limby w Tatrach. — Bull. intern. Acad. Polonaise sci. et lettr., Cl. sci. mathém. et natur., sér. B, Sciences naturelles, Vol. 1:241—252. 1934. With 3 tables.

In infection experiments with Peridermium pini from Pinus cembra of the High Tatra Mountains, the author obtained infection of Ribes nigrum L., R. rubrum L., var. hispidulum Jancz., R. petraeum Wulf. var. carpathicum (Kit.) Jancz., R. petraeum Wulf. var. Litwinowii Jancz., R. himalayense Decaisne var. glandulosum Jancz. and R. wallichii R. wallichii Jancz. and failed to infect Ribes manshuricum Kom. var. subglabrum Kom., R. manshuri cum Kom. var. glabrum Kom., R. multiflorum Kitaib., R. vulgare Lam., R. vulgare Lam. var. macrocarpum Jancz., R. triste Pall. var. pallidum Jancz., R. Warshewiczii Jancz., R. rubrum L., var. pubescens Swartz, R. rubrum L. var. scandicum (Held.) Jancz., R. petraeum Wulf. var. bullatum (Otto et Dietr.) Jancz, R. petraeum Wulf. var. caucasicum (Bieb.) Jancz., R. petraeum Wulf. var. atropurpureum Jancz., R. petraeum Wulf. var. altissimum (Turcz.) Jancz., R. petraeum Wulf. var. tomentosum Maxim., R. latifolium Jancz., var. japonicum Jancz., R. longeracemosun Fe., R. aureum Pursh, R. hudsonianum Rich. var. canalense Jancz., R. curvatum Small, R. fasciculatum Sieb. et Zucc. var. japonicum Jancz., R. sardoum Mart., R. alpinum L., R. Maximowiczii Batal., R. Koehneanum Jancz. On the basis of experiments

reported, the author maintains that Cronartium ribicola from the Tatra Mountains constitutes a separate physiological race, possibly identical with the race on Pinus cembra var. sibirica, but differentiated from the race on the Weymouth pine (Weymouthskiefer).

Rouppert, K. and B. Namysłowski. Zmudzkie grzby zebrane przez prof. d-ra Edwarda Janczewskiego. — Sprawozd. Komisji fizjograf. Akad. Umiejętności w Krakowie, Vol. 63:161—165. 1909.

Ten species of rust fungi reported from Lithuania.

Rouppert, K. and A. Wróblewski. Zapiski grzyboznawcze z Zaleszczyk. — Kosmos, Vol. 35:260—265, Lwow. 1910.

Twenty-one species of rust fungi reported from Galicia and Bukovina.

Saccardo, P. A. Mycetes sibirici, addito conspectu mycetum in Sibiria praesertim circa Minussinsk in Kirghiscia hucusque observatorum. — Bull. Soc. Roy. bot. Belgique, Vol. 28:77—120. 1889. Three tables.

The list comprises 115 names of fungi collected by Mart'yanov. A summary of all fungi known in the flora of Siberia and the former Orenburg Province is given on pp. 103—118. According to Thümen and Saccardo, there are 861 names in all; 178 names of rust fungi are reported.

Saccardo, P. A. Mycetes sibirici. Pugillus alter. — Bull. Soc. bot. Italiana, pp. 213—221, Firenze. 1893.

The 78 species of fungi were collected by Mart'yanov mainly in the environs of Minusinsk. Of the 35 species of rust fungi, many are described without reference to habitat.

Saccardo, P. A. Mycetes sibirici. Pugillus tertius. — Malpigia, Anno X, fasc. V—VII, pp. 258—270, Genoa. 1896.

The 214 fungi named were collected by Mart'yanov near Minusinsk and by Kytmanov near Eniseisk. Of these fungi, 122 were new at that time for the flora of Siberia (a total of 1,023 species were known); 39 species of rust fungi are reported (Nos. 78—116).

Samuelsson, G. Studien über die Entwicklungsgeschichte der Blüten einiger Bicornes-Typen. — Svensk. Bot. Tidskrift, 7 (2): 97—188. 1913.

Schiffner, V. Cryptogamae Karoanae Dahuricae. — Österr. bot. Ztschr., 66 (4):137—139. 1896.

Puccinia fusca on Pulsatilla from the environs of Nerchinsk, Transbaikal Region, reported on p. 139.

Schröter, J. Über einige amerikanische Uredineen. — Hedwigia, 14 (11): 161—172. 1875.

Cronartium ribicola from the village of Stepankova in former Moscow Province is mentioned on p. 168.

Siemaszko, W. Zapiski grzyboznawcze z gubernii Wilinskiej. — Sprawozd. posiedz. Towarz. naukow. Warsawskiego, Wydzial nauk matemat. i przyrodniczych. Posiedzenie z dnia 12 marca 1914 g., 7 (3): 1—12. 1914. (Preprint).

The list includes 12 species of rust fungi.

Siemaszko, W. Badania mycologiczne w górach Kaukazu. Arch. nauk. biol. Towarz. naukow Warszawskiego, 1 (14): 1—57. 1923.

The 70 species of rust fungi listed were collected mainly in Transcaucasia.

Siemaszko, W. Notatki grzyboznawcze-geograficzne. — Acta Soc. bot. Poloniae, 2 (1): 1—9, Warsaw. 1924.

Rust fungi are reported from the Bialowieza Forest and several other regions of the USSR.

Sivers, M. Über die Getreideroste. — Balt. Wochenschr. Landw., Vol. 24: 389—394, 425. 1886. Figs.

Sivers, M. Zur Getreiderostfrage. — Balt. Wochenschr. Landw., Vol. 25: 80—82, 112—113. 1887.

Sommier, S. and E. Levier. Enumeratio plantarum anno 1890 in Caucaso lectorum. — Acta Horti Petropol., Vol. 16: 1—586. 1900. Tables I—XLIX.

Fungi identified by Magnus (Nos. 1798—1818) are listed on pp. 537—545; among them are 3 rust species.

Sorokin, N. Notiz über die Verbreitung des Cronartium. — Hedwigia, 15 (6): 84—87. 1876b.

Sorokin, N. Noch einmal über Verbreitung des Cronartium ribicola. — Hedwigia, 15 (10): 145—146. 1876c.

Sorokin, N. Beitrag zur Kenntnis der Kryptogamenflora der Uralgegend. — Hedwigia, 16 (3—4): 40—44, 49—53. 1877.

The same as in Trudy Obshchestva Estestvoispytatelei pri Imperatorskom Kazanskom Universitete, 5 (6): 1—28, 1876a, save for more indications on the host plants.

Sydow, H. Fungi orientales caucasici novi. — Vestnik Tiflisskogo Botanicheskogo Sada, Vol. 26: 5—6. 1913.

Puccinia platypoda from Armenia (Turkish) is described.

Sydow, H. Einzug einer asiatischen Uredinee (Puccinia Komarowii Tranzsch.) in Deutschland. — Ann. mycol., 33 (5 — 6): 363 — 384. 1935.

Sydow, H. and P. Über die auf Anemone narcissiflora auftretenden Puccinien. — Ann. mycol., Vol. 1: 33 — 35. 1903.

A description of P. Schelliana Thüm. from the former Orenburg Province is given among the species of Puccinia parasitic on Anemone.

Sydow, H. and P. Einige neue parasitische Pilze aus Russland. — Ann. mycol., Vol. 10: 214 — 217. 1912.

A description of six new species of rust fungi from the Treboux collection, mainly from the environs of Novocherkassk.

Sydow, P. et H. Monographia Uredinearum, Berlin, Vol. I: Genus Puccinia, 1904, XXV + 972 p., cum XLV tab.; Vol. II: Genus Uromyces, 1910, XIX+ 396 p., cum 14 tab.; Vol. III: Pucciniaceae (excl. Puccinia et Uromyces) — Melampsoraceae — Zaghouaniaceae — Coleosporaceae, 1915, 722 p., cum 32 tab.; Vol. IV: Uredineae imperfectae, 1924, IV + 671 p.

The monographs establish the diagnoses of all rust fungi of the USSR, the descriptions of which were known or available to the authors. Separate issues appeared from 1900 to 1924.

Szafer, N. and A. Wróblewski. — Rocznik sekcji dendrologicznej Polsk. Towarz. botanicznego, Vol. 7: 286 — 294. 1951.

The list consists of 96 names many of which belong to the Uredinales.

Szakien, B. Przyczynek do znajomości rdzy Wileńszczyzny i Grodzienszczyzny. — Kosmos, Vol. 51: 75 — 138, Lwow. 1926.

The 160 rust fungi are mainly from the environs of Vilnius and the Bialowieza Forest.

Szakien, B. Nowy przyczynek do znajomości rdzy Wileńczczyzny. — Prace Towarzystwa Przyjaciól Nauk w Wilne. Wydz. Nauk mat. i przyr., Vol. 11: 17, Vilnius. 1937.

Thümen, F. Diagnosen Thümen's "Mycotheca universalis." Cent. I — XVIII. — Flora, p. 203. 1876; p. 169 — 174, 204 — 208. 1877; p. 87 — 94, 104 — 112. 1878; p. 94 — 96, 103 — 110, 123 — 128, 137 — 139. 1879; p. 312 — 332. 1880; p. 237 — 239, 251 — 255, 266 — 272, 297 — 303. 1881.

Thümen, F. Beiträge zur Pilz-Flora Sibiriens, I. — Bull. Soc. imp. natur. Moscou, 52 (1): 128 — 152. 1877.

Thirty-six species of rust fungi are described; ten are new species.

Thümen, F. Beiträge zur Pilz-Flora Sibiriens, II. — Bull. Soc. imp. natur. Moscou, 53 (2): 206 — 258. 1878.

The list comprises 87 species of rust fungi of which 15 are new.

Thümen, F. Beiträge zur Pilz-Flora Sibiriens, III. — Bull. Soc. Imp. natur. Moscou, 55 (1): 172 — 104. 1880a.

Forty-eight species of rust fungi of which 7 are new.

Thümen, F. Beiträge zur Pilz-Flora Sibiriens, IV. — Bull. Soc. imp. natur. Moscou, 55 (2): 198 — 233. 1880b.

Forty-three species of rust fungi of which 7 are new.

Thümen, F. Fungi aliquot novi in terre Kirghisorum (imperii Rossici) a Juliano Schell lecti. — Nuovo botanico Italiano, 12 (3): 196 — 199. 1881.

On pp. 196 — 197, the species **Aecidium ligulariae**, **A. nonneae**, **A. limnanthemi**, **Puccinia kirghisica**, **P. Schelliana** are described; all five species are from the environs of Orenburg, **Uredo sonchina** is from the environs of Ufa.

Thümen, F. Beiträge zur Pilz-Flora Sibiriens, V. — Bull. Soc. imp. natur. Moscou, 56 (3): 104 — 134. 1881 (1882).

The list comprises 25 species of rust fungi (Nos. 855 — 879).

Tranzschel, W. Kulturversuche mit **Caeoma interstitiale** Schlecht. (**Caeoma nitens** Schw.). — Hedwigia, 32 (5): 257 — 259. 1893b.

Tranzschel, W. **Aecidium Leontites** W. Tranzschel n. f. ad interim. — Acta Horti Bot., Vol. 2: 91, Yuriev. 1901b.

Latin diagnoses of fungi collected in the Caucasus.

Tranzschel, W. Über einige auf Grund von irrtümlicher Bestimmung der Nährpflanzen aufgestellte **Puccinia** Arten. — Ann. mycol. Vol. 2: 157 — 161. 1904b.

Tranzschel, W. Kulturversuche mit Uredineen im Jahre 1906. (Vorläufige Mitteilung). — Ann. mycol., Vol. 5: 32. 1907a.

Culture experiments with 4 species: **Puccinia funci**, **P. eriophori**, **P. Dietrichiana** sp. nov. and **P. Porri**.

Tranzschel, W. Kulturversuche mit Uredineen im Jahre 1907. (Vorläufige Mitteilung). — Ann. mycol., Vol. 5: 418. 1907b.

Tranzschel, W. Diagnosen einiger Uredineen. — Ann. mycol., Vol. 5: 547 — 551. 1907c.

Eleven new species from the Far East, Central Asia and the European part of the USSR are described.

Tranzschel, W. Kulturversuche mit Uredineen im Jahre 1908. (Vorläufige Mitteilung). — Ann. mycol., Vol. 7: 182. 1909a.

T r a n z s c h e l, W. Revision der in Central-Asien von Herrn Ove Paulsen gesammelten Uredineen. — Bot. Tidsskrift, Vol. 29:154 —157, København. 1909b.

T r a n z s c h e l, W. Die auf der Gattung Euphorbia auftretenden autötischen Uromyces Arten. — An. mycol. Vol. 8:1 —35. 1910b.

T r a n z s c h e l, W. Beiträge zur Biologie der Uredineen. III. Trudy Botanicheskogo Muzeya Imperatorskoi Akademii Nauk, Vol. 7:1 —20. 1910c.

T r a n z s c h e l, W. Kulturversuche mit Uredineen in den Jahren 1911 —1913. (Vorläufige Mitteilung). — Mycol. Centrl. (Jena), Vol. 4:70 —71. 1914b.

T r a n z s c h e l, W. La ruggine del Ciliegio: "Leucotelium cerasi" (Béreng.) n. gen. n. comb. ("Puccinia cerasi" Cast.) ed il suo stadio ecidiale. — Rivista di patologia vegetale, 25 (5 —6):1 —7. 1935c. (Preprint).

T r e b o u x, O. Beiträge zur Kenntnis der ostbaltischen Flora, VII. 1. Verzeichnis von parasitischen Pilzen aus Kreise Pernau. — Korr.-Bl. Naturf.-Ver., Vol. 55:91 —101, Riga. 1912a.

Of the 160 species listed, 101 are rust species; the respective hosts and date of collection are given.

T r e b o u x, O. Verzeichnis von Pilzen mit neuen Nährpflanzen. — Hedwigia, Vol. 52:316 —318. 1912b.

The index lists 33 species (Nos. 25 —57) of rust fungi collected in the environs of Novocherkassk.

T r e b o u x, O. Infektionsversuche mit parasitischen Pilzen, I. — Ann. mycol. Vol. 10:73 —76. 1912c.

The genetic ties between the aecial stage on Ranunculus illyricus L. and Uromyces festucae Syd. on Festuca ovina L. have been established; the fungus is not transferrable from R. illyricus to Poa bulbosa L. and P. pratensis L. Connection was established between Aecidium on Euphorbia virgate W. K. and Uromyces astragali Opiz (the fungus does not pass onto Caragana frutescens, Medicago falcata, Trifolium arvense, etc.), and at the same time between the aecia on the same host and Uromyces genistae-tinctoriae Pers. on Caragana frutescens. Experimental infections were carried out with aecio-(?) urediospores of Uromyces striata Schroet., aecio- (?) and teliospores of Puccinia junci Str., aeciospores from Taraxacum officinale Wigg. on Carex stenophylls Wahl. (=Puccinia silvatica Schroet.), urediospores from Puccinia cesatii Schroet. (on Androspogon Andropogon ischaemum L.). Teliospores of Puccinia stipae Opiz (= P. stipina Tranz.) from Stipa capillata L. successfully infected

species of Salvia, Thymus serpylium L. and Ajuga chia Schreb.; but failed to infect Salvia verticillata L., Ajuga genevensis L. and Phlomis tuberosa L. (Novocherkassk).

Treboux, O. Infektionsversuche mit parasitischen Pilzen, II. — Ann. mycol., Vol. 10:303—306. 1912d.

The results of experimental infections with spores of Aecidium on Ranunculus illyricus, Uromyces festucae Syd., Puccinia australis Koern., Puccinia litoralis Rostr. and others.

Treboux, O. Infektionsversuche mit parasitischen Pilzen, III. Ann. mycol., Vol. 10:577—563. 1912e.

Experimental infections with spores of the following rust fungi are reported: Puccinia polygoniamphibii Pers. (obtained aecia on species of Geranium), P. permixta Syd on Dipiachne serotina Lk. (obtained aecia on Allium), P. stipina Tranz. (obtained aecia on Lamium amplexicaule L., Glechoma, Lamium and others), P. glumarum, Ericks, et Henn. (herediospores from Agropyrum repens P. B. produced infection in Triticum vulgare, Hordeum vulgare and Bromus mollis), P. agropyrina Erickss. and P. dispersa Erickss. (urediospores of the latter infected Agropyrum repens P. B.), P. coronifera Kleb. (aeciospores from Rhamnus cathartica infected numerous species of cereals), Uromyces polygoni Pers (on Rumex acetosella L. failed to infect), U. genistrae-tinctoriae Pers. (on Caragana arborescens), U. striatus Schroet., U. astragali Opiz, U. caryophyllinus Schrank (aeciospores from Euphorbia Gerardiana Jacq. infected species of Dianthus), U. Schroeteri de Toni.

Treboux, O. Infektionsversuche mit parasitischen Pilzen, IV. — Ann. mycol., Vol. 12:482 —483. 1914.

Trzebinski, J. Przyczynek do znajomości grzybów pasożytniczych południowo-wschodniej Czechii, Litwy i północnowschodniej Polski. — Prace Tow. Przyj. Nauk w Wilne. Wydz. nauk. mat. i przyr, Vol. 11: 163—175, Wilno. (1936) 1937.

The 104 parasitic fungi listed include rust fungi from Lithuania.

Tumilowiczowna, Zofja. Spis grzybów z okolic Wołkowyska. — Prace Towarzystwa Przyjaciol Nauk w Wilnie. Wydz. nauk matem. i przyrod. IX. Prace Zakładu systematyki roslin i Ogrodu Botanicznego Univ. St. Batorego w Wilnie, No. 8:1—18. 1935.

The list comprises 59 species of rust fungi (Nos. 44—102). Host plants, collection sites, stage of development of fungi and date of collection are given.

Vestergreen, T. Micromycetes rariores selecti, Fasc. 1—17, Stockholm. 1899—1902.

A list of fungi with diagnoses and notes from "Botaniska Notiser" (1900, pp. 27—44; 1902, pp. 113—179). The rust fungi are from Ezel (Saare) Island and other regions of the Baltic States.

Vestergreen, T. Verzeichnis nebst Diagnosen und Bemerkungen zu meinem Exsiccatenwerke "Micromycetes rariores selecti," Fasc. 1—17. — Botaniska Notiser, pp. 153—173. 1899; pp. 27—44. 1900; pp. 113—179. 1902.

Vestergreen, T. Zur Pilzflora der Insel Oesel. — Hedwigia, Vol. 62: 76—117. 1903.

The names of 79 rust fungi are given; many of the species are accompanied by extensive comments.

Vilkaitis, V. Apie ruduju rudziu Puccinia dispersa ziemojima. — Zem. Ukio Akad. Metr., Vol. 9:73—82, Dotnuva. 1935.

Vleugel, J. Zur Kenntnis der auf der Gattung Rubus vorkommenden Phragmidium Arten. — Svensk Bot. Tidskr., 2 (2):123—138. 1908.

Four species are described, their habitat in Karelia is indicated.

Weinman, J. A. Enumeratio stirpium in agro Petropolitano sponte crescentium. SPb. 1837. IV+320 p.

Willkomm, M. Ein neuer Rostpilz der Fichte. — Tharander's Forstliches Jahrbuch, Vol. 20:115. 1870.

Peridermium and Chrysomyxa from the Baltic States.

Wolff, R. Vortrag über die Rostpilze des Getreides. — Korr.-Bl. Naturf.-Ver., Vol. 23:118—120, Riga. 1880.

Wolff, R. Vortrag über eigenen Forschungen uber die Entwicklungsgeschichte auf der Kiefer schmarotzenden Aecidium pini. — Korr.-Bl. Naturf.-Ver., Vol. 23:9—12, Riga. 1880.

Wróblewski, A. Przyczynek do znajomosci grzybow Pokucia, (Data on the Fungi of Pokutye. Part I.). — Sprawozd. Komisji Fizjograf. Akad. Umiejętności w Krakowie, Vol. 67:147—178. 1913.

More than 200 species of rust fungi are listed.

Wróblewski, A. Przyczynek do znajomoşci grzybów Podola (Data on the Fungi of Podolia, Part I). — Sprawozd. Komisji Fizjograf. Akad. Umiejętnosci w Krakowie, Vol. 68:3—15. 1914.

More than 100 species of rust fungi.

Wróblewski, A. Drugi przyczynek do znajomości grzybów Pokucia i Karpat Pokuckich (Additional Data on the Fungi of Pokutye and Carpat-Pokutye). — Sprawozd. Komisji Fizjograf. Akad. Umiejętnośti w Krakowie, Vol. 50:82—154. 1916.

More than 150 species of rust fungi.

Wróblewski, A. Wykaz grzybów zebranykh w latach 1913—1918 z Tatr. Pienin, Beskidow Wschodnich, Podkarpacia, Podola, Roztocza i innych miejscowosci (Index of the Fungi Collected 1913—1918 in the Tatra Mountains, Pieniny, Eastern Beskids, Foothills of the Carpathian Mountains, Podolia, Roztocz and other Sites. Part I. Phycomycetes, Ustilaginaceae, Uredinales and Basidiomycetes). — Sprawozd. Komisji Fizjograf. Akad. Umiejętności w Krakowie, Vols. 55 — 57: 1 —50. 1922.

Yarwood, C. E. Mechanism of Acquired Immunity to a Plant Rust. — Proc. Nat. Acad. Sci. USA, 40 (6): 374 —377. 1954.

Zalewski, A. Rozbiór prac, dotyczących flory polskiej (od roku 1880 do 1885 wlącznie). — Kosmos, Vol. 31: 414 —491, Lwow. 1896.

There are corrections in the identifications by Błoński and other authors.

Zweighbaumowna, Z. Grzybki pasorzytnicze na róslinach kwiatowych, zebrane w latach 1904 —1911 w Smile gub. Kijowskiej i okolicach przez J. Trzebińskiego. — Pamiętnik fizjograf., Vol. 25: 1 —13, D. 1918.

Rust fungi are listed.

Major Bibliographical Sources

(Basic bibliographies appear in the book by D. V. Lebedev (see below). The most complete list of Russian works on rust fungi will be found in the book by N. A. Naumov, 1939 (see Russian bibliography)).

Bukhgol'ts, F. Raboty finlyandskikh mikologov po poslednie gody (Recent Works by Finnish Mycologists). — Acta Horti bot., Vol. 8: 97 —101, Yuriev. 1907.

Abstracts of works by Finnish mycologists.

Bunge, N. A. (editor). Ukazatel' russkoi literatury po matematike, chistym i prikladnym estestvennym naukam, meditsine i veterinarii, (Index of Russian Bibliography on Mathematics, Pure and Applied Natural Sciences, Medicine and Veterinary Science), Vols. 1 —6, Kiev. 1873 —1878.

Bychkova, E. Kh. Bibliografiya Saratovskoi oblasti. Vol. 2. Flora i rastitel'nost' yugo-vostoka Evropeiskoi chasti SSSR. Pod red. A. D. Fursaeva (Bibliography on the Saratov Region. Vol. 2. Flora and Vegetation of the Southern Areas of the European Part of the USSR), Saratov. 1950. 201 p.

Bibliography on fungi on pp. 38 —42.

Dubnyak, K. Materialy sil'sko-hospodars'koyi bibliografiyi Ukrayini, 1925 (An Agricultural Bibliography of the Ukraine, 1925). — Rad Selyanyn, 1 (1): VIII+ 226, Kharkiv. 1927.

Elenkin, A. A. Obzor botaniko-geograficheskoi literatury sporovykh rastenii za 1904 —1906 gody (Review of Phytogeographical Literature on Sporophytes for 1904 — 1906). — Izvestiya Sankt Peterburgskogo Botanicheskogo Sada, Supplements to Vol. 5: 68. 1905; Vol. 6: 82 — 106. 1906; Vol. 7: 57 — 69. 1907.

Flerov, B. K. Literaturnye dannye o gribakh Moskovskoi gubernii (References on the Fungi of Moscow Province). — Trudy Sektsii po Mikologii i Fitopatologii Russkogo Botanicheskogo Obshchestva, Trudy Moskovskogo Otdela, Vol. 1: 101 — 105. 1923.

The list comprises 42 entries of references used in 1920.

Gombocz, Endre. A magyar Növénytani Irodalom Bibliográfiăja 1901 — 1925 (Bibliographie der Ungarischen botanischen Literatur 1901 — 1925). Budapest. 1936.

Material on mycology on pp. 264 — 278.

Hryniewiecki, Boleslaw. Rozwoj botaniki w Polsce. — Polska Akad. Umiejętności, Historia nauki polskiej w monografiach, Vol. 8: 53. 1948.

Critical review of the history of botany in Poland from 1795 to 1939. There are data on the history of mycology and phytopathology.

Ito, S. Mycological Flora of Japan. Vol. 2. Basidiomycetes. No. 3. Uredinales — Pucciniaceae. Uredinales imperfecti. Tokyo. 1950. 435 p.

Fungi of the fam. Pucciniaceae are described; synonymy and bibliography; diagnoses in Japanese; 454 figures. Species of the southern Sakhalin and other regions of the Soviet Far East are described.

Kalandadze, L. P. (Ed.). Nauchnaya literatura v Gruzii. Sel'skoe khozyaistvo. Bibliograficheskii ukazatel' (Bibliography of Scientific Publications in the Georgian SSR. Agriculture). Tbilisi. 1951. 411 p.

For plant diseases, see pp. 275 — 331.

Katalog polskiej literatury matematyczno-przyrodniczej. — Polska Akad. Umiejętności, 616 pp., Krakow. 1939.

Extensive annotated bibliography of Polish publications, including those on mycology.

Komarov, V. L. Bibliografiya k flore i opisaniyu rastitel'nosti Dal'nego Vostoka (Bibliography on the Flora and Plant Description of the Far East). — Zapiski Yuzhno-Ussuriiskogo Otdela Russkogo Geograficheskogo Obshchestva, Vol. 2 : 1 — 278, Vladivostok. 1928.

Fourteen studies of mycology are reported.

Lavrov, N. N. Flora gribov i slizevikov Sibiri i smezhnykh oblastei Evropy, Azii i Ameriki (Flora of Fungi and Molds of Siberia and Adjacent Regions of Europe, Asia and America), Vol. 1. — Trudy Biologicheskogo Nauchno-Issledovatel'skogo Instituta Tomskogo Gosudarstvennogo Universiteta, Seriya E, Biologiya, Vol. 3, No. 1, Botanicheskii (Botany), 12 — 59. 1937.

Annotated bibliography of articles on the mycology and phytopathology of Siberia (182 non-Russian titles). Non-Russian collectors and scientists number 48.

Lavrov, N. N. Flora gribov i slizevikov Sibiri (Flora of Fungi and Moulds of Siberia), Vol. 2. — Trudy Biologicheskogo Nauchno-Issledovatel'skogo Instituta Tomskogo Gosudarstvennogo Universiteta, Seriya E, Biologiya, 3 (2): 1 — 132. 1938.

A bibliography of Russian papers on the mycology and phytopathology of Siberia and the Far East. About 600 articles (Nos. 183 — 593 + some 170 unnumbered titles) are annotated. The list of collectors (continued, see Vol. 1) contains 269 names (a total of 312 names).

Lebedev, D. Vl. Vvedenie v botanicheskuyu literaturu SSR (A Bibliography of USSR Botany). — Moskva-Leningrad, Izdatel'stvo AN SSSR. 1956. 382 p.

The book lists the most important references on botany, including fungi.

Lepik, E. Bibliographische Beiträge zur ostbaltischen Pilzflora, I (1791 — 1929). — Arb. Inst. Phytopathol. Univ. Tartu (Estonia), No. 3: No. 3 : 27 — 88. 1930.

The list comprises 90 titles of floristic works with short annotations or references to other published annotated bibliographies. Publications on phytopathology (90 titles) cover 1938 — 1921.

Lindau, G. and P. Sydow. Thesaurus litteraturae mycologicae et lichenologicae ratione habita praecipue omnium que adhunc scripta, sunt de mycologia applicata quem congresserunt, Vols. 1 — 5, Lipsiis. 1907 — 1917.

Litvinov, D. I. Bibliografiya flory Sibiri (Bibliography on the Flora of Siberia). — Trudy Botanicheskogo Muzeya Imperatorskoi Akademii Nauk, Vol. 5 : 458 p. 1909.

There are no entries on pure mycology in the bibliography. The compiler does not mention the mycological material in several of the listed works.

Margolina, D. L. Flora i rastitel'nost' Tadzhikistana. (Flora and Vegetation of Tadzhikistan). Edited by B. A. Fedchenko. Moskva-Leningrad. 1941. 346 p.

Merrill, E. and E. Walker. A Bibliography of Eastern Asiatic Botany. 1938. XIII + 19 pp.

References to phytopathology of the Far East.

Mikhailova, M. G. Flora ta roslynnist' URSR. Bibliografiya (A Bibliography on the Flora and Vegetation of the Ukrainian SSR). Kyyiv. 1938. 61 p.

The bibliography lists 1706 titles of botanical studies of which 1,426 are in Russian and Ukrainian.

Montrésor c—te de Bourdeille. Les sources de la flora des provinces qui entrent dans la composition de l'arrondissement scolaire de Kieff. Contenant les gouvernements Kieff, de Volhynie, de Podolie, de Tchernigoff et de Poltava. (L'histoire et la bibliographie botanique de ces pays). — Bull. Soc. imp. natur., 6 (1 —261): 322 —381, Moscou. 1892 (1893); 7 (262 —571): 420 — 496. 1893 (1894).

An annotated bibliography on botany, including mycology.

Murashkinskii, K. E. Inostrannaya literatura po mikoflore Zap. Sibiri za 1923 —1933 gody (A Bibliography of Non-Russian References on the Mycoflora of Western Siberia from 1923 to 1933). — Omskoe byuro Obshchestva kraevedeniya, Omsk. 1933. 4 p.

Twenty-four annotated titles are listed.

Prozorovskii, N. A. Bibliograficheskii ukazatel' botanicheskikh programm i instruktsii (1864 —1933). (A Bibliography of Curricula and Instructions on Botany (1864 —1933)). — Sovetskaya Botanika, No. 3: 133 —154. 1935.

An extensive annotated bibliography of instructions and guides on fungi.

Regel, C. (K. Regelis). Lietuvos floras šaltiniai. Fontes florae Lituanae. — Univ. Vydauti Magni, Matematikos-Gamtos Fakult., 13 (2): 7 —27, Darbai. 1939. (Scripta Horti bot. Univ. Vydauti Magni, VI).

Regelis, K. Fontes florae Lituanae — Lietuvos floros šaltiniai. — Scripta Horti bot. Univ. Vydauti Magni, Vol. 1: 221 —252. 1931. (Matematikos-Gamtos Fakult. Darbai, V, 1930 —1931).

Regelis, K. Lietuvos floras šaltiniai, II. Fontes florae Lituanae, II. — Scripta Horti bot. Univ. Vydauti Magni, Vol. 2: 5 —28. 1932. (Matematikos-Gamtos Fakult. Darbai, VII, 1930 —1932).

An annotated bibliography on botany (86 titles), including fungi.

Regelis, K. Fontes florae Lituanae, VII. (Quellen der Flora von Litauen, VII). — Scripta Inst. et Horti bot. Univ. Vilniensis, II (VIII) Vilni aus Univ. Matem. — Gamtos Fakult. Darbai, I (XIV), 2/, pp. 301—455. 1942.

An annotated bibliography (289 entries) with a subject index including earlier bibliographies published by the author.

Ryakhovskii, N. A. Russkaya literatura po rzhavchine khlebnykh zlakov (A Bibliography of Russian References on Cereal Rusts). — Zashchita Rastenii, No. 9:155—162. 1936.

Savulescu, Tr. Monografia uredinalelor din Republica Populară Română, Vols. 1—2:1166, Bucharest. 1953.

Species from the Moldavian SSR are listed.

Slawinski, W. Przychynek do znajomości flory okolic Wilna. Cyešć. I. — Historia i bibliografia Wydawnictwa Towarzystwa Przyjaciol Nauk w Wilno, III., pp. 1—32, Vilna. 1922. Tables I—VII.

Szymkiewicz, D. Bibliografia flory polskiej. — Prace monograficzne Komisji fizjograf., Vol. 2:1—1 58. 1925.

A bibliography on fungi — Nos. 154—362 (pp. 22—35); index of geographical areas.

Trautvetter, E. K. Florae Rossicae fontes. — Trudy Imperatorskogo Sankt Peterburskogo Botanicheskogo Sada, Vol. 7:1—342. 1880.

An annotated bibliography comprising 1656 entries (annotations in Latin).

Wang Iun Chang. Index Uredinearum Sinensium, p. 157, Peking. 1951.

List of fungi indicating the hosts, and list of hosts indicating the fungi. Bibliography, pp. 150—155.

Zalewski, A. Rozbiór prac dotyczacych flory polskiej od roku 1880 do 1895. — Kosmos, Vol. 7:1—78, Lwow. 1896.

Zhukovskii, A. V. and N. A. Ryakhovskii. Spisok entomologicheskoi i fitopatologicheskoi literatury po Voronezhskoi i Kurskoi oblastyam (A Bibliography on the Entomology and Phytopathology of the Voronezh and Kursk Regions). — Trudy Voronezhskoi Zashchity Rastenii, 1 (12):131—181. 1936.

I. Entomology and applied zoology, pp. 135—164 (835 Nos.); II. Phytopathology and mycology, pp. 164—178 (350 Nos.); III. General problems of plant protection, pp. 178—181 (79 Nos.).

Zverozomb-Zubovskii, E. Materialy k poznaniyu vreditelei i boleznei sel'skokhozyaistvennykh rastenii Donskoi oblasti (spisok literatury) (A Bibliography on the Pests and Diseases of Farm Plants in the Don Region. Novocherkassk. 1919. 14 p.

The bibliography lists 206 articles, reviews, etc.

SYSTEMATIC PART

TAXONOMY OF THE ORDER UREDINALES — RUST FUNGI

167 Obligate parasites on vascular plants, unable to grow in artificial cultures on dead substrates. Mycelium ramified, pluricellular, developing inside the nutrient tissue, usually intercellularly, producing spores under the epidermis or in the integumentary cells. The variform spores in scattered or relatively compact sori, whence they later emerge through the torn tissue. Overwintered spores (teliospores), or their analogues, germinate into cylindrical basidia, dividing crosswise into 4 cells, each of which bears one basidiospore (sporidium) on a short sterigma. In some species basidia are formed inside the teliospores, whence they rise to the surface borne on the sterigmata. Other spore forms — aeciospores and urediospores, apart from spermatia, germinate in the usual germ tube.

Of the 128 genera known, more than 40 are monotypic; the number of species attains 4,600. In the USSR there are approximately 50 genera and more than 1,000 species.

The order **Uredinales** is divided into two families.

Key to Families

I. Teliospores nonpedicellate, produced intracellularly in the epidermis or subepidermally, scattered or joined in crusts, cushions (pulvini), or small columns, unicellular, rarely divided into 2 or more cells, occasionally in chains. Species mostly heteroecious. Aecia with peridium or caeomoid, mainly on conifers but also on angiosperms . . . . I. Family **Melampsoraceae**.

II. Teliospores pedicellate, pedicels sometimes poorly developed or breaking off, uni- or pluricellular, variform, joined in compact or loose and pulverulent cushions, or in diversely shaped sori. Aecia with or without peridium, occasionally with rudimentary peridium. In heteroecious species no aecia known on conifers . . . . II. Family **Pucciniaceae**.

I. Family MELAMPSORACEAE

Aecia either with well developed peridia or caeomoid (or with early disappearing peridia); aeciospores with distinct striate structure of the walls. Urediospores develop singly, or in short chains; in the latter the

wall structure is striate. Uredia are frequently covered by a peridium formed of polyhedral or tubular cells, or else they are paraphysate. Teliospores always nonpedicellate, densely crowded in flat crusts of one or more layers, or in convex cushions, or small columns, unicellular or divided by longitudinal septa into several cells, in the latter case usually produced in the epidermal cells of the host plant or scattered subepidermally. Germinate an external promycelium, or (in **Coleosporieae**) an inner promycelium resulting in partition of the teliospore.

Key to Subfamilies (Tribes)

I. Aecia with clearly pronounced peridium, developing on conifers, on species of **Pinaceae**.
  A. Urediospores single on individual pedicels. Uredia covered by peridium (sometimes very delicate), rarely with marginal epiphyses, or devoid of peridium and paraphyses.
    1. Teliospores longitudinally pluricellular, or unicellular, united in monostratic crusts or dispersed subepidermally, or developing intracellularly in the leaf epidermis . . . . I. **Pucciniastreae** (p. 256)
    2. Teliospores unicellular, produced in series, grown together in subepidermal lenticular bodies, or in cylindrical columns rising outside . . . . II. **Cronartieae** (p. 343)
  B. Urediospores mostly in short chains. Uredia devoid of protective peridia.
    1. Teliospores in occasionally ramifying chains, joined in naked cushions. Each cell of the chain initiates an external 4-celled promycelium . . . . III. **Chrysomyxeae** (p. 362)
    2. Teliospores with waxy cushions, initially unicellular, subsequently divided by transverse septa into 4 cells transforming into inner promycelium so that each one of the 4 cells gives rise to a basidiospore . . . . . IV. **Coleosporieae** (p. 382)

II. Aecia caeomoid, developing on conifers or on angiosperms . . . . V. **Melampsoreae** (p. 422)

I. Subfamily (Tribe) PUCCINIASTREAE

Hiratsuka, A Monograph of the Pucciniastreae, Mem. Tottori Agric. Coll. IV, 1936, IX + 374 pp.

Aecia on conifers of the family **Pinaceae**, with well-developed peridia. Urediospores produced singly, occasionally in two different forms; uredia covered by peridia or surrounded by paraphyses.[1] Teliospores with longitudinal septa, divided into 2—4 or more cells, or unicellular.

[1] Detailed information about the structure and development of uredia, urediospores, and haustoria is given by Moss (E. H. Moss. The Uredo Stage of the Pucciniastreae. Ann. Bot., vol. XL, 1926, p. 813—847, pl., 21 fig.). It should be noted that, according to Moss, urediospores are produced singly in all genera of **Pucciniastreae**, whereas other authors maintain that in some genera they develop in short chains.

169 Key to Genera of Subfamily **Pucciniastreae**

I. Teliospores develop intracellularly in the epidermis of the host.
   A. Teliospores unicellular.
      1. On ferns.
         a. Urediospores with orange-colored contents, with pores . . . . 3. **Hyalopsora** Magn.
         b. Urediospores with colorless contents, germ pores scarcely perceptible . . . . 1. **Milesia** White.
      2. Not on ferns.
         a. Urediospores absent, telia cover considerable areas of stems . . . . 7. **Calyptospora** Jul. Kühn.
         b. Urediospores present, telia on leaves, of insignificant size . . . . 6. **Thekopsora** Magn.
   B. Teliospores unicellular, urediospores present, their contents colored . . . . 4. **Melampsorella** Schroet.

II. Teliospores develop subepidermally.
   A. Teliospores unicellular.
      1. On ferns; aecio- and urediospores with colorless contents . . . . 2. **Uredinopsis** Magn.
      2. Not on ferns; aecio- and urediospores with orange-colored contents . . . . 5. **Pucciniastrum** Otth.
   B. Teliospores unicellular . . . . 8. **Melampsoridium** Kleb.

Note. Dietel in Engler u. Prantl, Die Natürlichen Pflanzenfamilien, Bd. 6, 1928 referred to **Pucciniastreae** even the genus **Mesospora** Diet., which is hardly acceptable. Separation of genus **Mesospora** is based only on assumptions which seem most improbable and unverified (see **Melampsora hypericorum** (DC) Schroet. (= **Mesospora hypericorum** Diet.) p. 480).

1. Genus MILESIA F. B. White

F. B. White, Sect. Nat. IV, 1877, p. 162; Faull, Taxonomy and Geographical Distribution of the Genus Milesia, Contr. Arn. Arb. Harvard Univ., II, 1932; The Biology of Milesian Rusts, Journ. Arnold Arboret. XV, 1934, p. 50—85.

Syn.: **Milesina** P. Magn., Ber. Deutsch. bot. Ges. XXVII, 1909, S. 325; Hirats., A Monograph of the Pucciniastreae, Mem. Tottori. Agric. Coll. IV. 1936, p. 374.

Spermagonia usually hypophyllous, colorless, immersed. cup-shaped or spherical in vertical section, subcuticular or subepidermal; flexuous, colorless hyphae protruding from the stomata were observed in some species.[1]

Aecia hypophyllous, erumpent, cylindrical, white. Peridium colorless, irregularly rupturing at the apex; inner wall of peridial cells verrucose

[1] E. Mayor, Bull. Soc. Neuchât. sci. natur., t. LXI, 1936, p. 120 (**Milesia polypodii** White); L. M. Hunter, Journ. Arn. Arb., vol. XVII, 1936, p. 112 (in 6 species of **Milesia**).

or with short fine ridges. Aeciospores white, in chains, with intermediate cells, from globoid to ovoid or ellipsoid, verrucose; spores on one side
170 more coarsely warted than on the other; spore wall and contents colorless.

Uredia subepidermal, covered by peridium. Peridium thin, hemispherical or almost flat, rupturing centrally through the apical pore, occasionally through irregular slit; peridial cells smooth, polygonal, occasionally radially elongate in the lower part of the peridium. Urediospores white, single, on short pedicels, obovoid, ellipsoid, or subgloboid, occasionally irregular, "bone-shaped," with blunt ends, echinulate, verrucose, or smooth; pores present, but not distinct.[1]

Teliospores colorless, inside epidermal cells, rarely unicellular, usually consisting of several cells, rarely of many longitudinally septate cells, in one layer; usually a few spores in each epidermal cell, rounded, or, more often irregular, their shape corresponding more or less to that of the epidermal cell which they frequently fill to capacity; spore wall smooth, colorless, thin, with one inconspicuous pore at the apex of each cell.

Urediospores develop at the end of summer and then again in the spring on overwintered leaves. Teliospores develop usually in the spring on overwintered leaves; they may be found rarely in the fall; teliospores germinate in the spring after a short rest period. Aecia of all species, in which they are known, develop on fir species (**Abies**), uredio- and teliospores on ferns.

Of the 51 species known, 11 are in Europe and the Caucasus, 26 in eastern Asia (of which 3 species also common in Europe, and one species in eastern North America), 11 in North America, 5 in South America, 2 in North Africa, 1 in southern Africa, and 1 in New Zealand. The occurrence of characteristic species in the southern hemisphere, where no fir species are found, is puzzling; these species probably propagate from year to year by urediospores. In the USSR 10 species are known at present; of these, 4 species have been found in the Caucasus, along the coast of the Black Sea. 1 — in the Crimea, 2 — in the Far East, 6 — in the western Ukraine (2 species in common with the Caucasus, 1 in common with the Far East). These fungi are easily overlooked owing to their pale sori on almost imperceptible patches; they must be searched for.

Key to Species of the Genus **Milesia**

I. Species on **Asplenium**.
- A. Uredia from rounded to linear, peridia of loosely joined cells. Urediospores echinulate . . . . 1. **M. feurichii** (Magn.) **Faull.**
- B. Uredia rounded, peridia of tightly joined cells.
  - 1. Urediospores echinulate.
    - a. Wall of peridial cells and spore thin, 1.0 μ, or less . . . . 2. **M. magnusiana** (Jaap) Faull.
    - b. Wall of peridial cells and spore considerably thicker, 1.5 — 2.5 μ . . . . 3. **M. murariae** (Magn.) Faull.
  - 2. Urediospores verruculose . . . 4. **M. asplenii-incisi** Faull.

[1] Cf.: E.H. Moss. Uredo Stage of the Pucciniastreae. —Ann. Bot., vol. XL, 1926, p. 825.

II. On **Blechnum**. Urediospores coarsely echinulate . . . . 5. **M. blechni** (Syd.) Arth.

III. On **Cheilanthes** . . . . 6. **M. wilczekiana** (R. Maire) Kupr. et Tranz. comb. nov.

IV. On **Coniogramma** . . . .

171 . . . 7. **M. coniogrammes** (Hirats. f.) Kupr. et Tranz. comb. nov.

V. On **Cryptogramma** . . . . 8. **M. darkeri** Faull.

VI. Species on **Dryopteris** (and **Microlepia**).

A. Urediospores smooth.

1. Urediospores truncate at apex, "bone-shaped" . . . . 9. **M. miyabei** (Kamei) Faull.

2. Urediospores obovate or elongate . . . . 10. **M. itoana** (Kamei) Kupr. et Tranz. comb. nov.

. . . . 10a. **M. dilatata** Faull.

B. Urediospores delicately verruculose, or almost smooth . . . . 11. **M. fructuosa** Faull.

C. Urediospores echinulate.

1. Urediospores delicately echinulate.

a. Urediospores $14-30 \times 10.5-18\mu$ . . . . 12. **M. carpatica** (Wróbl.) Faull.

b. Urediospores $17-32 \times 10-17\mu$, almost smooth . . . . 12a. **M. dryopteridis** (Kamei) Faull.

c. Urediospores $17.5-35 \times 12.5-21\mu$ . . . . 12b. **M. erythrosora** (Faull) Hirats.

2. Urediospores $28-48 \times 15-22\mu$ distinctly echinulate. Uredia pustulate . . . . 13. **M. kriegeriana** (Magn.) Arth.

VII. Species on **Polypodium**.

A. Urediospores echinulate . . . . 14. **M. polypodii** White.

B. Urediospores verrucose, particularly at apex . . . . 15. **M. jezoensis** (Kamei et Hirats.) Faull.

C. Urediospores smooth, fusoid . . . . 15a. **M. polypodophila** (Bell) Faull.

D. Urediospores smooth, ovoid or ellipsoid . . . . 15b. **M. laeviuscula** (Diet. et Holw.) Faull.

VIII. Species on **Polystichum**.

A. Urediospores smooth (or almost smooth).

1. Urediospores small, $18-29\mu$ (on an average, about 24μ) long . . . . 16. **M. exigua** Faull.

2. Urediospores large, $29-43\mu$ (on an average, about 36μ) long . . . . 17. **M. vogesiaca** (Syd.) Faull.

B. Urediospores sparsely echinulate, $22-40\mu$ (on an average, about 30μ) long . . . . 18. **M. whitei** Faull.

IX. Species on **Phyllitis** (**Scolopendrium**) . . . . 19. **M. scolopendrii** (Fuckel) Arth.

On **Asplenium**

1. **Milesia feurichii** (Magn.) Faull, Contr. Arn. Arb. II, 1932, p. 27, tab. IV, fig. 13, a–d; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 62, 65.

Syn.: **Milesina Feurichii** Magn., Ber. Deutsch. bot. Ges. XXVII, 1909, S. 325, Taf. XIV, Fig. 8; Klebahn, Kryptogfl. M. Brandb. Va, 1914, S. 852; Syd., Monogr. Ured. III, 1915, p. 478; Fragoso, Fl. Iber. Ured. II, 1925, p. 279; Hirats., Monogr. Pucciniastreae, 1936, p. 126, tab. IV, fig. 1.

Melampsorella Feurichii Magn., Ber. Deutsch. bot. Ges. XX, 1902, S. 609, Taf. XXVII, Fig. 1—5; Sacc., Sylloge, XVII, 1905, p. 267; Liro, Ured. Fenn., 1908, p. 493.

Hyalopsora Feurichii (Magn.) Ed. Fisch., Uréd. Schweiz, 1904, S. 475; Hariot, Uréd., 1908, p. 254; Migula, Kryptog.-Fl. Deutschl. III, 1, 1910,
172 S. 472; Trotter, Fl. Ital. Crypt. Ured., 1914, p. 390.

Spermagonia and aecia unknown.

Uredia from round to linear, 0.1—0.2 mm across, and up to 2 mm long, usually on petioles, occasionally hypophyllous (rarely also epiphyllous), scattered on olive or brownish areas, frequently completely covering the frond and petioles; peridia typical, or formed in part by loosely joined cells; peridial cells isodiametric, or slightly elongate, 7—17μ across, their walls 0.5—2.0μ thick; no paraphyses (demonstrated by Magnus). Urediospores on pedicels up to 18μ long, obovoid, ellipsoid, or subgloboid, 28—44 × 17—26 (on an average, about 30 × 20μ), wall, 0.5—1.5μ thick, rather finely and sparsely echinulate (Figure 8).

Telia on overwintered leaves, blades, veins and petioles amphigenous, more frequently on the brown patches on the underside of leaves. Teliospores one or more intracellular, intraepidermal, often in stomata, frequently filling the cells, 1- to 15-celled, one pore in the outer wall of each cell; teliospore cells 8—27 × 8—19μ.

Basidia 4-celled, 60—80 × 5.0—5.5μ. Basidiospores globoid to broad-obovate, 7—9 × 7.0—7.5μ.

Uredio- and teliospores on **Asplenium septentrionale** (L.) Hoffm.

General distribution: western Europe. In the USSR not yet found.

2. **Milesia magnusiana** (Jaap) Faull, Contr. Arn. Arb. II, 1932, p. 32, tab. IV, fig. 15, a—d; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 63—65.

Syn.: **Milesina Magnusiana** Jaap, Fg. selecti exs. No. 623, 1913 (nomen); Verh. Bot. Ver. Prov. Brand. LVII, 1915, S. 16; Syd., Monogr. Ured. III, 1915, p. 477; Sacc., Sylloge, XXIII, 1925; p. 845; Fragoso, Fl. Iber. Ured. II, 1925, p. 280; Hirats., Monogr. Pucciniastreae, 1936, p. 145.

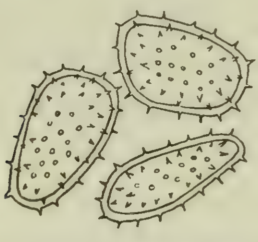


FIGURE 8. **Milesia feurichii** (magn.) Faull on **Asplenium septentrionale** (L.) Hoffm. Urediospores × 600. (Orig.)

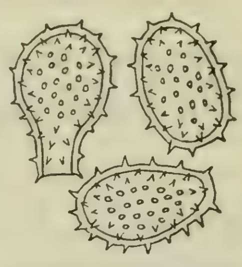


FIGURE 9. **Milesia magnusiana** (Jaap) Faull on **Asplenium (Adiantum) nigrum** L. Urediospores × 600. (Orig.)

Spermagonia and aecia unknown.

Uredia round or slightly elongate, 0.1 — 0.4 mm across, subepidermal, occasionally in linear rows on olive or brown patches on the leaves, scattered or loosely grouped; peridium hemispherical, delicate; peridial cells in upper part of peridium irregularly angular, isodiametric or slightly elongate, in the lower part radially elongate, 8 — 17 μ across, with walls less than 1 μ thick. Urediospores on short pedicels, obovoid, ellipsoid,
173 rarely pyriform or almost globoid, 28 — 47 × 17 — 20 μ (on an average, 35 × 20 μ); wall, 0.5 — 1.2 μ thick, rather strongly echinulate; echinules sometimes unevenly scattered (Figure 9).

Teliospores unknown.

On **Asplenium** (**Adiantum**) **nigrum** L., in France (the Riviera, Corsica) and Italy (Liguria). In the USSR the host is found in the Caucasus, the Crimea (rarely), near Kamenets-Podol'skii, and in Tien Shan.

3. **Milesia murariae** (Magn.) Faull. Contr. Arn. Arb. II, 1932, p. 14, a — d; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 63 — 65.

Syn.: **Milesina murariae** (P. Magn.) Syd., Monogr. Ured. III, 1915, p. 477; Grove, Journ. Bot. LIX, 1921, p. 311; Fragoso, Fl. Iber. Ured. II, 1925, p. 279; Hirats., Monogr. Pucciniastreae, 1936, p. 128, tab. IV, fig. 3.

Uredo murariae P. Magn., Ber. Deutsch. bot. Ges. XX, 1902, S. 611; Fischer, Ured. Schweiz, 1904, S. 538; Hariot, Uréd., 1908, p. 310; Klebahn, Kryptogfl. M. Brandb. Va, 1914, S. 855, Fig. V, 5; Trotter, Fl. Ital. Crypt. Ured., 1914, p. 452.

Spermagonia and aecia unknown.

Uredia hypophyllous and petiolicolous, round, 0.1 — 0.2 mm across, or elongate, up to 3 mm long, on petioles and petiolules, subepidermal, on olive or brownish areas frequently involving entire fronds; peridium hemispherical, rather compact; peridial cells in the upper part of peridium irregularly angular, isodiametric or slightly elongate, in the lower part of peridium radially elongate, 7 — 15 μ across; walls, 1.5 — 2.0 μ thick. Urediospores on very short pedicels, obovoid, ellipsoid, or subgloboid, 23 — 37 × 14 — 23 μ (on an average, 30 × 18 μ); walls, 1.5 — 2.5 μ thick, strongly and rather sparsely echinulate (Figure 10).

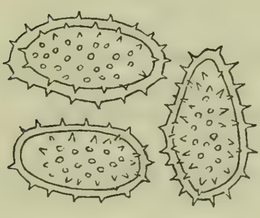


FIGURE 10. **Milesia murariae** (Magn.) Faull on **Asplenium ruta-muraria** L. Urediospores, × 600. (Orig.)

Telia on overwintered leaves, hypophyllous, on extensive indefinite bright brown areas, frequently involving entire fronds. Teliospores intraepidermal, often also within the guard cells, frequently filling the cells; 1- to 15-celled, with one pore at the apex of each cell; cells 10 — 25 × 7 — 16 μ, thin-walled.

On **Asplenium ruta-murariae** L.

General distribution: western Europe, USSR (Crimea, at the sources of the Bel'bek River near Biyuk-Uzenbash).

4. **Milesia asplenii-incisi** Faull, Contr. Arn. Arb. II, 1932, p. 30, tab. VII, fig. 29, a — d; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 63, 65.

Syn.: **Milesina asplenii-incisi** (Faull) Hirats., Monogr. Pucciniastreae, II, 1939, p. 144, tab. IV, fig. 2.

Spermagonia and aecia unknown.

Uredia round, 0.1 — 0.25 mm across, subepidermal, in groups or scattered
174 on pale green or light brown areas of the leaves; peridium hemispherical, compact; peridial cells isodiametric or irregularly polygonal, 8 — 16 × 8 — 14 μ, walls slightly yellowish, approximately 2 μ thick. Urediospores on short pedicels, obovoid, ellipsoid, or, occasionally, subgloboid, 20 — 26 × 14—17 (on an average, 22 × 15) μ; walls thin (0.7 — 1.0 μ), with scattered minute, punctate verrucules.

Teliospores unknown.

On **Asplenium incisum** Thunb. in Japan. May occur in the USSR in the Far East.

On Blechnum

5. **Milesia blechni** (Syd.) Arth., Bot. Gaz. LXXIII, 1922, p. 61, pr. p.; Faull, Contr. Arn. Arb. II, 1932, p. 37, tab. II, fig. 5, a — d; Hunter, Journ. Arn. Arb. XVII, 1936, p. 127, tab. 186, fig. 30 (spermagonia); Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 63, 66.

Syn.: **Melampsorella blechni** Syd., Ann. mycol. I, 1903, p. 537; Hariot, Uréd., 1908, p. 269; Bubák, Rostpilze Böhmens, 1908, S. 214; Migula, Kryptog.-Fl. Deutschl. III, 1, 1910, S. 490; Sacc., Sylloge, XVII, 1905, p. 266.

Milesina blechni (Syd.) Syd., Ann. mycol. VIII, 1910, p. 491; Grove, Brit. Rust Fungi, 1913, p. 377, fig. 282; Klebahn, Kryptogfl. M. Brandb. Va, 1914, S. 853, 904; Syd., Monogr. Ured. III, 1915, p. 478; Fragoso, Fl. Iber. Ured. II, 1925, p. 280, 384, fig. 137; Hirats., Monogr. Pucciniastreae, 1936, p. 117, tab. IV, fig. 4.

Aecidium pseudocolumnare J. Kühn, Hedwigia, XXIII, 1884, S. 168, pr. p.; Hariot, Uréd., 1908, p. 300, pr. p.; Klebahn, Kryptogfl. M. Brandb. Va, 1914, S. 856, 863, 903, Fig. X, 3; Syd., Monogr. Ured. IV, 1924, p. 12, pr. p.

Biol. Klebahn, Ztschr. Pflanzenkr. XXVI, 1916, S. 262, Fig. 2 (aeciospore).

Spermagonia on leaves of current year, amphigenous, mostly hypophyllous, immersed, more or less flask-shaped in section; initially probably subepidermal, covered by epidermal cells, the inner walls of which are gradually destroyed; 110 — 175 μ wide, 105 — 150 μ deep. Spermatia narrow-cylindrical, 4 — 6 μ long.

Aecia hypophyllous on leaves of current year, in two rows, white, cylindrical, 0.3 — 0.4 μ across, rupturing at the apex; peridial cells polygonal, vertically elongate, arranged in one layer, 24 — 40 × 12 — 24 μ; outer wall smooth, about 1 μ thick; inner wall thin and densely verrucose; the warts often in irregular rows, 2.5 — 3.0 μ thick. Aeciospores ellipsoid, ovoid, or globoid, mostly elongate, white, 27 — 36 × 21 — 27 μ, densely and rather coarsely warted, except on one side where the warts are minute.

Uredia 0.17 — 0.4 mm across, hypophyllous, subepidermal, scattered or loosely grouped on olive or brownish areas, pustular; peridium hemispherical; upper cells of peridium isodiametric or polygonal, 7 — 12 μ across,

lower cells radially elongate with thin walls. Urediospores obovoid or ellipsoid, 26—45 × 15—23μ (on an average, about 33 × 19μ); pedicels short (up to 12μ), 6μ thick; spore wall thin (0.7 to 1μ), with scattered
175 rather coarse echinulations (Figure 11).

Telia on overwintered leaves, on indefinite brown areas, occasionally involving entire pinnae. Teliospores intracellular, in the lower epidermis, occasionally within the guard cells, rarely also in the upper epidermis, sometimes filling the cells; 1- to 70-celled, in the guard cells to 12-celled; cells 3—16 × 6—11μ.

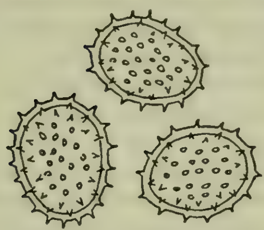


FIGURE 11. Milesia blechni (Syd.) Arth. on Blechnum spicant (L.) With. Urediospores, × 600. (Orig.)

In Europe Kühn incorporated under the designation **Aecidium pseudocolumnare** all white-spored aecia on **Abies**, belonging to species of the genera **Milesia** and **Uredinopsis**. The uredio- and teliospores are found almost throughout Europe on **Blechnum spicant** With. In the USSR only the uredial stage is found. The species **Milesia blechnicola** Hirats. f. (Bot. Mag. Tokyo, XLVIII, 1934, p. 40) with white urediospores covered with elongate echinules is found in Japan on **B. spicant** With. var. **nipponicum** Miyabe et Kudo (**B. nipponicum** Makino); the spores are similar to those of **Hyalopsora aculeata** Kamei on the same host, but the contents of urediospores of the latter species are colored. A species very close to **Milesia blechnicola** also found in Japan, on **Blechnum amabile** Mak., is **Milesia kameiana** Hirats. f. (Monogr. **Pucciniastreae**, 1936, p. 139); distinguished by larger urediospores. So far, it has not been reported in the Soviet Far East on **Blechnum**.

General distribution: Europe (including the Caucasus).

On **Blechnum spicant** With. EUROPEAN PART: U. Dns. (in the eastern Carpathians (A. Wróblevski)); CAUCASUS: W Transc. (V. Siemaszko and Yu. Voronov).

In experimental infections with teliospores from **Blechnum** Klebahn obtained (l. c., 1936) spermagonia and aecia on **Abies alba** Mill. and **A. cephalonica** Lond., and succeeded in infecting **Blechnum** with the aeciospores obtained.

On Cheilantes

6. **Milesia wilczekiana** (R. Maire) Kupr. et Tranz. comb. nov.

Syn.: **Milesina Wilczekiana** R. Maire, Bull. Soc. hist. nat. Afrique Nord. XX, 1929, p. 281, tab. XIX, fig. 4, 5; Hirats., Monogr. Pucciniastreae, 1936, p. 146.

Spermagonia and aecia unknown.

Uredia hypophyllous, minute, round or elliptical, 0.2—0.5 × 0.2—0.35 mm, yellowish-orange, covered by the epidermis, later exposed; peridia present. Urediospores subgloboid, ellipsoid or pyriform, 19—39 × 15—19μ; wall finely echinulate, 1.0—1.5μ thick, colorless.

Teliospores unknown.

On **Cheilantes pteridioides** (Reich.) C. Chr. in Morocco. In the USSR hosts are found in Dagestan and mountainous Turkmenia.

On Coniogramma, Pteris

7. **Milesia coniogrammes** (Hirats.) Kupr. et Tranz. comb. nov.

Syn.: **Milesina coniogrammes** Hirats., Bot. Mag. Tokyo, XLVIII, 1934, p. 45, fig. 6; Hirats., Monogr. Pucciniastreae, 1936, p. 92, tab. V, fig. 6.

176 Spermagonia and aecia unknown.

Uredia hypophyllous, round or elliptical, 0.12 — 1.3 mm across, subepidermal, on brownish patches; peridium hemispherical or pyriform; upper peridial cells isodiametric or irregularly polygonal, 10 — 18 μ across, the lateral cells radially elongated. Urediospores obovoid or fusoid, 25 — 42.5 × 15 — 22.5 μ (on an average, 32 × 17 μ); spore wall less than 1 μ thick, smooth, although scattered, minute echinules or verrucules are evident on some spores, especially at the apex.

Telia on overwintering leaves, mostly hypophyllous, on yellowish-brown to dark brown spots. Teliospores intracellular epidermal, colorless, round or irregular in shape, consisting of one or more cells, and with thin, smooth walls. On **Coniogramma fraxinea** Diels, **C. japonica** Diels, **Pteris cretica** L. and **P. multifida** Poir. in Japan, from Honshu to Taiwan. Teliospores found only on **Pteris cretica**. In the USSR encountered on **Coniogramma fraxinea** in the Far East (Sakhalin).

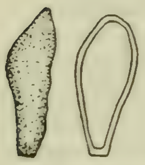


FIGURE 12. Milesia darkeri Faull on Cryptogramma acrostichoides R. Br. Urediospores. (After Arthur)

On Cryptogramma

8. **Milesia darkeri** Faull, Contr. Arn. Arb. II, 1932, p. 46, tab. VI, fig. 24, a — d; Arth., Manual Rusts U. S. a. Canada, 1934, p. 9, fig. 15; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 63, 66.

Syn.: **Milesina Darkeri** (Faull) Hirats. Monogr. Pucciniastreae, 1936, p. 95.

Spermagonia and aecia unknown.

Uredia hypophyllous and on petioles, round, 0.2 — 0.3 mm across, subepidermal, scattered or in loose groups on olive or brownish patches; peridia hemispherical, compact; peridial cells isodiametrically to irregularly polygonal, 8 — 14 μ across, the walls 1.5 — 2.0 μ thick. Urediospores on short pedicels, obovoid or ellipsoid, usually asymmetric, 36 — 64 × 15 — 20 μ (on an average, about 50 × 17 μ); spore wall thin (about 1 μ), smooth (Figure 12).

Telia on overwintering leaves, hypophyllous, occasionally epiphyllous, on brown patches; sometimes spreading over the entire frond. Teliospores intracellular, epidermal, sometimes in the stomatal cells, frequently filling the cells; from 1- to 25-celled, with pore at the apex of each cell; cells, 11 — 25 × 8 — 21 μ.

On **Cryptogramma acrostichoides** R. Br. in northwestern America, in the state of Oregon, and in British Columbia. In the USSR the host is found in Kamchatka.

On Dryopteris

9. **Milesia miyabei** (Kamei) Faull, Contr. Arn. Arb., II, 1932, p. 129, Tranzschel, Consp. Ured., Moscow, 1939, pp. 62–64.

Syn.: **Milesina Miyabei** Kamei, Trans. Sapporo Nat. Hist. Soc. XII, 1932, p. 169; Hirats., Monogr. Pucciniastreae, 1936, p. 64.

Spermagonia hypophyllous on leaves of current year, not numerous,
177 almost imperceptible, subepidermal, deeply immersed, almost spherical, 160–280 μ across, 190–240 μ high. Spermatia 4.8–7.6 × 16–2 μ.

Aecia on leaves of current year, white, cylindrical, up to 2.0 mm high, 0.5 mm across, deeply sunk; peridial cells tetragonal or hexagonal, frequently with rounded corners, overlapping, 17–26 × 23–41 μ, with outer walls thin and smooth, inner walls verrucose and thicker, 2–4 μ. Aeciospores globoid or ellipsoid, 15–29.5 × 14–24 μ (on an average, 22 × 18.5 μ), wall about 2 μ thick, for the most part verrucose.

Uredia 0.15–0.35 mm across, subepidermal, scattered in yellowish or brownish patches on leaves; peridium compressed — hemispherical, delicate. Urediospores colorless, clavoid, or wedge-shaped, narrowing at the base, truncate or, occasionally, rounded at the top, 26–55 × 11–20 μ (in samples from the Far East 27–36 × 11–16 μ); walls smooth, thin (about 1 μ), slightly thicker at the upper corners (sometimes 1 or 2 corners extending in spinules) (Figure 13).

Teliospores mature at the beginning of summer on both sides of overwintered leaves (in one case Kamei found absolutely immature teliospores in November); intraepidermal, with longitudinal or anticlinal septa, usually 3- to 5-celled, occasionally nonseptate, 22–52 × 11–26 μ, wall thin, smooth, colorless.

Basidiospores ovoid or ellipsoid, 11–13 × 7–10 μ.

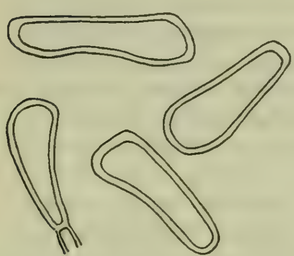


FIGURE 13. **Milesia miyabei** (Kamei) Faull on **Dryopteris crassirhizoma** Nakai. Urediospores, × 600. (Orig.)

General distribution: USSR (Far East), Japan.

On **Abies mayriana** Miyabe et Kudo — aecia in culture.

On **Dryopteris buschiana** (Fomin (= **D. filix-mas** aut. pr. p. probably identical with **D. crassirhizoma**) — FAR EAST: Uss. V. G. Tranzschel found the fungus in the urediospore stage, in August—September, in the Maikhe River basin, Shkotovo District, in four localities on the Murav'ev-Amurskii Peninsula near Okeanskaya, and along the Lyanchikhe River. In the mountains above Kharitonovka in the Maikhe River basin on **Abies nephrolepis** Maxim., and in two places near Okeanskaya on **A. holophylla** Maxim. Tranzschel collected at the same time aecia belonging, apparently, to **Milesia miyabei**.

Aecia on **Abies mayriana** Miyabe et Kudo were obtained by Kamei (Kamei, l. c.) by seeding germinating teliospores. Uredio- and teliospores on **Dryopteris crassirhizoma** Nakai, and **D. clarkei** Kuntze, in Japan.

10. **Milesia itoana** (Kamei) Kupr. et Tranz. comb. nov.

Syn.: **Milesina Itoana** Kamei, Trans. Sapporo Nat. Hist. Soc. XIV, 1935, p. 99, tab. I, fig. a–f; Hirats., Monogr. Pucciniastreae, 1936, p. 101.

Spermagonia as in **M. miyabei**.

Aecia similar to those of **M. miyabei**, but for the inner wall of peridial cells which is thicker ($4-7\mu$), not verrucose and densely striated. Aeciospores $20-38 \times 14-29\mu$ (for the most part $25 \times 20\mu$), densely and finely verrucose.

Uredia hypophyllous, 0.6 — 0.17 mm across, subepidermal, scattered, most
178 often bordering the leaves, immersed, or slightly pustular. Urediospores obovoid or elongate, $24-46 \times 14-26\mu$ (for the most part $30 \times 18\mu$); spore wall colorless, smooth, thin.

Teliospores intracellular in the epidermis of the upper and, particularly, of the underside of leaves, with smooth, colorless walls.

Aecia on **Abies mayriana** Miyabe et Kudo and on **A. sachalinensis** Mast.; uredio- and teliospores on **Dryopteris crassirhizoma** Nakai in western Japan. Positive results have been obtained in experimental cultivation of the fungi in both directions (Kamei, 1935).

In Japan fir trees are severely infected by aecia in the period between mid-September and the beginning of December. Uredio- and teliospores have been revealed in nature only in the spring. Presence of the fungi in the Maritime Territory (USSR) is most probable. It is unlikely that this species is different from **Milesia dilatata** Faull on **Dryopteris austriaca** (Jaeq.) Woynar. of Oregon State, in northwestern North America; aecia are not known (Faull, Contr. Arn. Arb., II, 1932, p. 49, tab. III, fig. 10, a–d; tab. IX, fig. 35; Arthur, Manual Rusts U. S. a. Canada, 1934, p. 8, fig. 11. — Syn.: **Milesia dilatata** (Faull) Hirats., l. c., p. 163).

11. **M i l e s i a   f r u c t u o s a** Faull, Contr. Arn. Arb. II, 1932, p. 51; Arth., Manual Rusts U. S. a. Canada, 1934, p. 8, fig. 12; Faull, Journ. Arn. Arb. XV, 1934, p. 54.

Syn.: **Milesina fructuosa** (Faull) Hirats., Monogr. Pucciniastreae, 1936, p. 115.

Peridermium balsameum Peck, Ann. Rep. N.Y. St. Mus. XXVII, 1875, p. 104, pr. p.

Milesia intermedia Faull, l. c., 1932, p. 64, tab. III, fig. 11, a—d; Journ. Arn. Arb. XV, 1934, p. 54, tab. 86 (aecia).

Milesina intermedia (Faull) Hirats., Monogr. Pucciniastreae, 1936, p. 107.

Milesia Kriegeriana Arth., N. Amer. Fl. VII, 1925, p. 686, pr. p.

Milesina Kriegeriana L. M. Hunter, Bot. Gaz. LXXXIII, 1927, p. 12, tab. II, fig. 10 (spermagonia).

B i o l. Faull, l. c., 1934.

Spermagonia hypophyllous, numerous, imperceptible, hemispherical, subcuticular, $84-137\mu$ wide, $59-84\mu$ high, frequently about $110 \times 71\mu$.

Aecia hypophyllous, on yellow patches, in two irregular rows, cylindrical, or laterally slightly constricted, 0.3 — 0.4 mm across, 0.2 — 1.0 mm high, white, opening at the top; their outer wall smooth, $2-3\mu$ thick, the inner wall $4.5-5.5\mu$ thick, slightly striated owing to the rather elongate papillae. Aeciospores globoid, ovoid, or ellipsoid, densely verrucose, $21-23 \times 19-23\mu$ (on an average, $27 \times 21\mu$); spore wall $1.0-1.5\mu$ thick (Faull, 1932, sub **M. intermedia**).

Uredia hypophyllous, subepidermal, scattered or in groups, circular or elongate, 0.15 — 0.35 mm across, covered by peridium; peridial cells irregularly polygonal, hyaline; walls $1.0-1.3\mu$ thick. Urediospores

obovoid, 22 — 36 × 14 — 21 μ, on an average mostly 29 × 17 μ, verruculose, more conspicuous at the apex, with the exception of individual, very short
179 spinules (Figure 14).

Teliospores intracellular, epidermal, amphigenous, mostly hypophyllous, pluricellular, smooth.

Initially Faull described two species, **M. fructuosa** and **M. intermedia**, but later suggested (Faull, Journ. Arn. Arb., XV, 1934, pp. 54, 77) that **M. intermedia** represents a state of the fungus **M. fructuosa** characteristic in the absence of the uredial stage, or its reduction in response to environmental effects.

Aecia on **Abies balsamea** (L.) Mill., uredio- and teliospores on **Dryopteris spinulosa** (Müll.) O. Kuntze, **D. spinulosa americana** Fern., **D. spinulosa fructuosa** Trudell, and **D. spinulosa intermedia** Under., in northeastern America. Connection between the stages was established by Faull (l. c., 1934). Hiratsuka (1936) revealed **M. fructuosa** on **Dryopteris subtripinnata** Kuntze in Korea.

Penetration of the fungus in the Soviet Far East is possible.

12. **Milesia carpatica** (Wróbl.) Faull, Contr. Arn. Arb. II, 1932, p. 55, tab. II, fig. 8, a—d; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 61 — 64.

Syn.: **Milesina carpatica** A. Wróbl., Spraw. Kom. fizyograf. Akad. Umiejetnośći w Krakowie, XLVII, 1913, pp. 166, 178; Bull. Acad. Sci. Kracovie (1915), 1916, tab. VIII, fig. 2, a; Syd., Monogr. Ured. III, 1915, p. 476; Sacc., Sylloge, XXIII, 1925, p. 846; Hirats., Monogr. Pucciniastreae, 1936, p. 121, tab. IV, fig. 6.

Spermagonia and aecia unknown.

Uredia round, 0.08 — 0.2 mm in diameter, covered by brownish stained epidermis, either single on dark brown patches, or in loose groups on brownish patches; peridia hemispherical, cells colorless, isodiametric or irregularly polygonal, 6 — 12 μ across, their walls 0.5 — 1.0 μ thick. Uredio-spores colorless, thin-walled (0.5 — 0.7 μ), obovoid, ellipsoid, or subgloboid, 14 — 27 μ long, 11 — 17 μ wide, on an average 20 × 14 μ; wall with short delicate echinules (Figure 15).

FIGURE 14. **Milesia fructuosa** Faull on **Dryopteris spinulosa** (Müll.) O. Kuntze. Urediospores. (After Arthur)

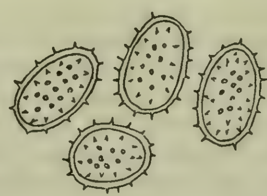


FIGURE 15. **Milesia carpatica** (Wróbl.) Faull on **Dryopteris filix-mas** (L.) Schott. Urediospores, × 600. (Orig.)

Telia amphigenous (mostly hypophyllous) on overwintering leaves, on indefinite brown patches. Teliospores intracellular, epidermal, rarely in

the guard cells, colorless, frequently filling the epidermal cells; having 1, 2, or more cells (30 or even more); cells 8—15 × 5.5—11μ, with
180 longitudinal septa; spore wall thin, smooth, colorless.

Uredio- and teliospores on **Dryopteris filix-mas** (L.) Schott. in western Europe and the USSR, on **D. spinulosa** (Müll.) O. Kuntze in Great Britain, on **D. crassirhizoma** Nakai and **D. miquelliana** in the Far East and Japan.

On Dryopteris filix-mas (L.) Schott. — EUROPEAN PART: U. Dns. (species described by Wróblevski from the vicinity of Kolomyya (Stanislav [Ivano-Frankovsk] Region), found also in Pogulyanka (Lvov Region); Belgorod Region).

On **Dryopteris crassirhizoma** Nakai var. **setosa** Miyabe et Kudo — FAR EAST: Sakhalin.

A species closely related to **Milesia carpatica**, **M. erythrosora** (Faull) Hirats. f. (sub **Milesina**) (syn. **Milesia carpatica** var. **erythrosora** Faull), is distributed in Japan on **Dryopteris erythrosora** Kuntze, **D. pseudo-erythrosora** Kodama, and **D. quadripinnata** Hayata, and is differentiated by slightly larger urediospores (17.5—35 × 12.5—21μ). Compare: Faull, Contr. Arn. Arb., II, 1932, pp. 57, 130; and Hiratsuka f., Monogr. Pucciniastreae, 1936, p. 121. Also closely related to **Milesia carpatica** according to Faull (l. c., p. 130), is **M. dryopteridis** (Kamei) Faull (**Milesina dryopteridis** Kamei, Trans. Sapporo Nat. Hist. Soc., XII, 1932, p. 171; Hiratsuka f., l. c., 1936, p. 109), found on **Dryopteris viridescens** Kuntze in Japan, differentiated, as described by Kamei, by the thicker walls (1.5—2.5μ) of urediospores. Hiratsuka indicated that the urediospore wall of this fungus is thicker than 1μ, and very discreetly echinulate, or almost smooth; urediospores 17—32 × 10—17μ.

13. **Milesia kriegeriana** (Magn.) Arth. (excl. descript.), Mycologia, VII, 1915, p. 176; Faull, Contr. Arn. Arb. II, 1932, p. 58, tab. III, fig. 9,a-d; Hunter, Journ. Arn. Arb. XVII, 1936, p. 35, tab. 176, fig. 3, 7 and p. 127, tab. 186. fig. 31; Tranzschel, Consp. Ured. URSS, Moscow, 1939, pp. 61, 64.

Syn.: **Melampsorella Kriegeriana** Magn., Ber. Deutsch. bot. Ges. XIX, 1901, S. 581, Taf. XXXIII; Sacc., Sylloge, XVII, 1905, p. 267; Hariot, Uréd., 1908, p. 269; Liro, Ured. Fenn., 1908, p. 494; Bubák, Rostpilze Böhmens, 1908, S. 214; Migula, Kryptog.-Fl. Deutschl. III, 1, 1910, S. 490; Trotter, Fl. Ital. Crypt. Ured., 1914, p. 427.

Hyalopsora Kriegeriana Ed. Fisch., Ured. Schweiz, 1904, S. 538.

Milesina Kriegeriana Magn., Ber. Deutsch. bot. Ges. XXVII, 1909, S. 325; Klebahn, Kryptogfl. M. Brandb. Va, 1914, S. 852; Syd., Monogr. Ured. III, 1915, p. 474, tab. XXI, fig. 164; Fragoso, Fl. Iber. Ured. II, 1925, p. 278; Hirats., Monogr. Pucciniastreae, 1936, p. 131.

Biol. Mayor, Bull. Soc. Neuchât. sci. natur. LVIII, 1933, p. 23; LXI, 1936; p. 117; Hunter, Journ. Arn. Arb., XVII, 1936, p. 26—37, tab. 176.

Spermagonia amphigenous, scattered, inconspicuous, flat, abundant, hemispherical, in cross section, subcuticular, 98—168μ wide, 94—168μ high. Spermatia narrow-elliptical, 3.5—5.0 × 1.5—2.0μ.

Aecia on leaves of current year, in two irregular rows on slightly yellowish patches, subcuticular, ellipsoid, or laterally constricted in cross section, cylindrical, 0.3—0.8 mm across, 0.5—1.3 mm high; peridia colorless, delicate, rupturing at the apex; peridial cells angular, vertically elongate,
181 overlapping, 36—38 × 16—52μ, with smooth outer walls and thick corrugated inner walls. Aeciospores ellipsoid, ovoid, or globoid, for the most part elongate, white, 22—48 × 20—30μ; spore wall verrucose, thin (about 1μ).

Uredia round, 0.1 — 0.3 mm in diameter, covered by brownish epidermis, scattered or in loose groups on yellowish or brown patches; peridia hemispherical, their cells isodiametric or irregularly polyhedral, 7 — 14μ across, laterally radially elongate, with colorless walls, approximately 1μ thick. Urediospores colorless, single, on pedicels 2 — 3μ long, obovoid or ellipsoid, 23 — 48 × 15 — 22μ (on the average, about 33 × 18μ); spore wall echinulate, thin (about 1μ) (Figure 16).

Telia are produced in fall on leaves of current year, hypophyllous on brown patches of indefinite extent. Teliospores intracellular, epidermal, sometimes within the guard cells, colorless, often filling the cells, from 1- to 40-celled, with longitudinal septa; teliospore cells 8 — 20 × 6 — 16μ, with thin, smooth, colorless walls.

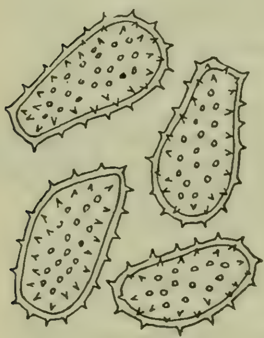


FIGURE 16. **Milesia kriegeriana** (Magn.) Arth. on **Dryopteris spinulosa** (Müll.) O. Kuntze. Urediospores, × 600. (Orig.)

Aecia on **Abies alba** Mill. in Switzerland. Uredio- and teliospores on **Dryopteris spinulosa** (Müll.) O. Kuntze, in the USSR and western Europe; on **D. spinulosa** var. **dilatata** Underw., in the USSR, Scotland and England; on **D. filix-mas** (L.) Schott. in the USSR and western Europe.

On **Abies alba** Mill. — to our knowledge no aecia of this fungus have been collected in the USSR.

On **Dryopteris spinulosa** (Mull.) O. Kuntze — EUROPEAN PART: U. Dns. (Stanislav Region, near Kolomyya).

On **Dryopteris spinulosa** var. **dilatata** Underw. (= **D. dilatata** A. Cr.) — EUROPEAN PART: U. Dns. (E Carpathians, Zavoiela).

On **Dryopteris filix-mas** (L.) Schott. — EUROPEAN PART: U. Dns. (Stanislav Region, Lvov Region).

N o t e . This species was reported also from East Siberia (Sayan Mts., Isakov Klyuch, 12 VII 1927) according to the collection of M. Ziling, in the work published by E. K. Murashkinskii and M. K. Ziling (Tr. Sib. inst. sel'sk. khoz. i lesov., X, p. 364, 1928). These specimens sent by Prof. Murashkinskii were examined by V. G. Tranzschel, who found only uredia of **Hyalopsora aspidiotus** (on **Dryopteris linneana**).

In addition to the above-mentioned rusts the following were described: On species of **Dryopteris**, in southern Japan, **Milesia microspora** (Hiratsuka f., l. c., 1936, p. 125, sub **Milesina** comb. nov. on **D. acuminata** Nakai, **D. africana** C. Chr. and **Microlepia pilosella** Moore), with echinulate, obovoid, or clavoid urediospores, 15 — 30 × 8 — 12.5μ. On **Dryopteris marginalis** A. Gray, in northeastern North America **Milesia marginalis** Faull et Watson, with echinulate, comparatively large (27 — 51 × 15 — 27μ) urediospores in small uredia. It is unlikely that these species are found in the USSR.

Mayor (l. c., 1933) found aecia in Switzerland on **Abies alba** and successfully infected **Dryopteris filix-mas** with the aeciospores; later (l. c., 1936) Mayor reported successful experimental infection of **Abies alba** With.,
182 teliospores from **Dryopteris filix-mas**. In England, Hunter (l. c.) infected **Abies alba**, **A. concolor**, and **A. grandis** with teliospores from **Dryopteris filix-mas**, and **D. spinulosa**. In other experiments, Hunter succeeded in transferring the fungus (I) from **Abies concolor** infected with teliospores

from D. filix-mas to D. filix-mas and D. spinulosa; the fungi (I) from A. grandis infected with teliospores from D. spinulosa and D. spinulosa dilatata onto D. spinulosa and D. filix-mas; aeciospores from A. concolor infected with fungi (III) from D. spinulosa dilatata caused infection of D. filix-mas, D. spinulosa dilatata, and D. spinulosa intermedia.

On Polypodium

14. **Milesia polypodii** White, Scott. Nat. IV, 1877, p. 162, fig. 5; Sacc., Sylloge, VII, 1888, p. 768; Faull, Contr. Arn. Arb. II, 1932, p. 81, tab. 1, fig. a—d; Hunter, Journ. Arn. Arb. XVII, 1936; pp. 26, 34, 128, pl. 176, fig. 1, 7 (1); pl. 185, fig. 25; pl. 186, fig. 32, 33; Tranzschel, Consp. Ured. URSS, Moscow, 1939, pp. 63, 66.

Syn.: **Melampsorella Dieteliana** Syd., Ann. mycol. I, 1903, p. 537; Sacc., Sylloge, XVII, 1905, p. 267; Hariot, Uréd., 1908, p. 269; Bubák, Rostpilze Böhmens, 1908, S. 214; Migula, Kryptog.-Fl. Deutschl. III, 1, 1910, S. 490; Trotter, Fl. Ital. Crypt. Ured., 1914, p. 426.

Milesina Dieteliana (Syd.) Magn., Ber. Deutsch. bot. Ges. XXVII, 1909, S. 325; Grove, Brit. Rust Fungi, 1913, p. 376, fig. 281; Klebahn, Kryptogfl. M. Brandb. Va, 1914, S. 854; Syd., Monogr. Ured. III, 1915, p. 479; Fragoso, Fl. Iber. Ured. II, 1925, p. 283, fig. 139; Hirats., Monogr. Pucciniastreae, 1936, p. 136.

Gloeosporium polypodii Aggery, pr. p., Bull. Soc. hist. nat. Toulouse, LXVIII, 1935, p. 123, fig. 123—136, tab. color. VII.

Biol. Hunter, l. c., 1936; Mayor, Bull. Soc. Neuchât. sci. nat. LXI, 1936, pp. 117—120.

Spermagonia amphigenous, on needles of current year, immersed, abundant, inconspicuous, colorless, hemispherical to slightly flask-shaped, 128—228μ wide, 105—194μ high, usually broader than high. Spermatia narrowly elliptical, 4—5 × 1.5—2μ; long sinuous hyphae arise in the center over the spermatial tips.

Aecia hypophyllous on needles of current year, in two irregular rows, one on each side of the midrib on slightly yellowing portions of the tissue, white, cylindrical, 0.5—0.7 mm in diameter, 1.0—1.5 mm high; peridium colorless, delicate, rupturing at the apex; peridial cells polygonal, elongate, vertically overlapping, 28—60 × 22—42μ, outer wall smooth and inner wall with a structure of coarse, short, irregularly orientated small ridges. Aeciospores ellipsoid, ovoid, or globoid, for the most part elongate, white, 28—54 × 20—36μ; spore wall hyaline, thin (about 1μ), compact, and rather coarsely warted, warts irregular in outline, tapering to a blunt point and partially deciduous.

Uredia hypophyllous, round, 0.1—0.2 mm in diameter, single or in loose groups on olive or brown areas; peridium delicate but firm; peridial cells isodiametric or polygonal, 8—18μ across; lower cells of peridium more or less radially elongated; cell walls 1μ thick or less. Urediospores short-stalked, obovoid or ellipsoid, sometimes subgloboid, 24—28 × 15—26μ (on an average, about 35 × 19μ); wall 1—2μ thick, diffusely and rather
183 strongly echinulate (Figure 17).

Telia on overwintered fronds, hypophyllous on brown areas of indefinite extent. Teliospores intradermal, occasionally in the guard cells, frequently filling the epidermal cells, uni- or pluricellular, with a single pore in each cell; cells 12—23 × 8—20μ.

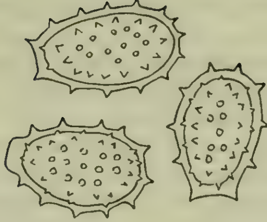


FIGURE 17. Milesia polypodii White on Polypodium vulgare L. Urediospores, × 600. (Orig.)

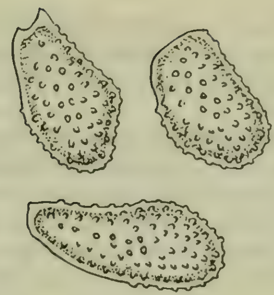


FIGURE 18. Milesia jezoensis (Kamei et Hirats.) Faull on Polypodium vulgare L. Urediospores, × 600. (Orig.)

Basidiospores subgloboid, 7—9μ across.

Aecia on **Abies alba** Mill. found in Switzerland. Uredio- and teliospores on **Polypodium vulgare** L. almost throughout western Europe.

On **Abies alba** Mill.— absent in the USSR collections.

On **Polypodium vulgare** L. — CAUCASUS: W Transc. (Sukhumi (Siemaszko, Voronov)).

Aecia on **Abies alba** and **A. concolor** were obtained in England by Hunter (l. c.) following experimental infection with teliospores. The aeciospores obtained on A. alba proved infective for **Polypodium vulgare**, but not for **Polystichum angulare** and **Phyllitis scolopendrium**. In Switzerland, Mayor (l. c.) also succeeded in infecting **A. alba** with basidiospores from **Polypodium vulgare** and vice versa — **P. vulgare** with aeciospores from **A. alba**.

15. **Milesia jezoensis** (Kamei et Hirats.) Faull, Contr. Arn. Arb. II, 1932, p. 87, tab. VIII, fig. 33, a—d; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 63, 66.

Syn.: **Milesina jezoensis** Kamei et Hirats. in S. Kamei, Trans. Sapporo Nat. Hist. Soc. XII, 1931, p. 32, fig. 1, 2C, 3; Hirats., Monogr. Pucciniastreae, 1936, p. 113.

Spermagonia hypophyllous scattered on yellowish areas, subcuticular, more or less globoid, 110—165μ, diameter 110—130μ high. Spermatia elongate, 6.5—9.0 × 2.0—3.0μ, on obclavate septate spermatiophore.

Aecia have not been described.

Uredia round, 0.2—0.45 mm diameter, hypophyllous, single or in loose groups forming olive or brown areas; peridium compact, hemispherical; peridial cells isodiametric, 8—15 × 17—11μ, lateral ones frequently radially
184 elongated, their walls 1.0—1.2μ thick. Urediospores on very short pedicels, obovoid, ellipsoid or subgloboid, occasionally irregular, 25—47 × 16—22μ, (on an average, about 35 × 19μ), spore wall finely verruculose particularly at the top, 0.7—0.9μ thick (Figure 18).

Telia on overwintered leaves, for the most part hypophyllous forming brown areas. Teliospores intradermal often filling the cells, from 1- to 12-celled, with a pore on each cell; cells 8—27 × 8—19μ.

Spermagonia were obtained in Japan on **Abies mayriana** Miyabe et Kudo, uredio- and teliospores found in Japan on **Polypodium "vulgare,"** apparently **P. virginianum** L. In the USSR the species may be found in the Maritime Territory.

In northeastern North America **Milesia polypodophila** (Bell) Faull is found in many places on **Polypodium virginianum** (Contr. Arn. Arb., II, 1932, p. 89, tab. I, fig. 4, a—b; tab. IX, fig. 36, 37; Arthur, Manual Rusts U.S. a. Canada, 1934, p. 6, fig. 8. — Syn.: **Milesina polypodophila** (Bell) Faull in Moss, Ann. Bot. XL, 1926, p. 815, text. fig. 8, 9, 21E, tab. XXXIV, fig. 9, 33—35), with fusoid urediospores sharply pointed at the apex, smooth, 38—68 × 13—21μ (on an average, 51—53 × 17—20μ), and teliospores of the usual type; here belong the spermagonia and aecia on **Abies balsamea** (L.) Mill. (= **Peridermium pycnogrande** Bell). The aecial stage, which is perennial, is remarkable in that it leads to the formation of loose "witches' brooms." Experimental infections with basidiospores caused none of the above-mentioned responses in the two years after infection (except for the faintly fading color of the leaves on **Abies**); spermagonia appear only in the third year, are very large, develop subepidermally, and are soon followed by the appearance of aecia. In western North America on **Polypodium californicum** Kaulf. (in California) and on **P. glycyrrhiza** D. C. Eaton (in the states of Washington, Oregon, and Alaska) **Milesia laeviuscula** (Diet. et Holw.) Faull (l. c., p. 95, tab. I, fig. 2, a—d and fig. 1 in text; Arthur, l. c., p. 7, fig. 9) is found in the stage of uredio- and teliospores. This species closely resembles **Milesia jezoensis** Faull but has smooth urediospores.

On P o l y s t i c h u m

16. **M i l e s i a e x i g u a** Faull, Contr. Arn. Arb. II, 1932, p. 100, tab. V, fig. 19, a—d; Tranzschel, Consp. Ured. URSS, Moscow, 1939, pp. 62, 65.

Syn.: **Milesina exigua** Faull, Journ. Arn. Arb. XII, 1931, p. 218, Hirats., Monogr. Pucciniastreae, 1936, p. 104.

Milesina vogesiaca Kamei, Trans. Sapporo Nat. Hist. Soc. XI, 1930, pp. 141—148, fig. 1, 2B, 3 (non Syd.).

B i o l. Kamei, l. c., 1930.

Spermagonia on leaves of current year, mostly hypophyllous, inconspicuous, colorless, immersed, slightly flask-shaped in section, 120—175μ wide, 110—160μ high. Spermatia 5.7 × 1.5—2μ.

Aecia on leaves of current year, white, cylindrical, 0.25 mm diameter by 0.5 mm high; peridial cells polygonal, elongated vertically, tesselate, in a single layer, 26—33 × 14—22μ; inner walls thick, densely warted, outer walls smooth and thin. Aeciospores globoid or ellipsoid, 19—25 × 14—22μ (usually 21 × 18μ); wall thin, verrucose.

Uredia hypophyllous, subepidermal, scattered or loosely grouped on
185 brownish patches, 0.1—0.2 mm across; peridia hemispherical; peridial cells isodiametric to irregularly polygonal, 8—15 × 8—12μ, their walls, 0.5—1.0μ thick. Urediospores obovoid, ellipsoid, or subgloboid, 18—29 × 14—17μ (on an average, 24 × 15μ) on short pedicels; wall smooth (or almost smooth), thin (Figure 19).

Telia on leaves of current year (in Europe and the Far East until October, in Japan until November, only uredia; teliospores germinate in

the spring), mostly hypophyllous, the infected areas becoming brown. Teliospores intraepidermal, occasionally also in the guard cells, usually filling the cells, multicellular (up to 30 cells or even more); cells $9-23 \times 9-20\mu$; spore wall thin, smooth, colorless, with a single pore.

Uredio- and teliospores are found in Europe and in the Far East on **Polystichum braunii** Fée, and in Japan also on **P. aculeatum** (L.) Roth. var. **retrorso-paleaceum** Kodama, **P. japonicum** Diels, and **P. tripteron** (Kze.) Presl. Hiratsuka, l. c., revealed **M. exigua** on **Microlepia strigosa** (Presl., and **Hypolepis punctata** Mett. on Shikoku Island and Taiwan.

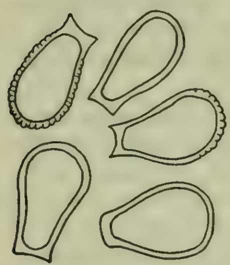


FIGURE 19. **Milesia exigua** Faull on **Polystichum braunii** Fée. Urediospores, × 600. (Orig.)

G e n e r a l d i s t r i b u t i o n: western Europe, USSR (Far East), Japan.

On **Abies mayriana** Miyabe et Kudo, **A. firma** Masters and **A. sachalinensis** Masters aecia were obtained in experimental infections carried out in Japan.

On **Polystichum braunii** Fée — EUROPEAN PART: U. Dns. (Stanislav Region, Knyazhdvor, near Kolomyya (urediospores collected by Wróblevski)).

On **P. tripteron** (Kze.) Presl. — FAR EAST: Uss. Maikhe River basin (urediospores collected by Tranzschel).

Kamei, l. c., obtained aecia on **Abies mayriana** Miyabe et Kudo, **A. firma** and **A. sachalinensis** Mast. infected with basidiospores from **Polystichum braunii**. Kamei referred the fungi collected on **Polystichum braunii** to **Milesia vogesiaca**, but Faull (l. c.) referred Kamei's specimens to **M. exigua**, although Kamei indicated that the fungi he described have larger urediospores (20×41, rarely $48 \times 15-22\mu$) corresponding to **Milesia vogesiaca**. Faull (l. c., p. 103) found that the urediospores in the material received from Kamei measured $17-32 \times 11-16.5\mu$ (on an average, $23.5 \times 13.5\mu$). According to Kamei, examination of dry spores revealed that the urediospores of typical **Milesia vogesiaca** as well as those of the fungus found by him have finely granular walls owing to the presence of numerous verrucules; a similar structure was seen in the specimens from the Soviet Far East on **Polystichum tripteron**; urediospores of these specimens measured $17-33 \times 11-17\mu$.

17. M i l e s i a v o g e s i a c a (Syd.) Faull, Contr. Arn. Arb. II, 1932, p. 103, tab. IX, fig. 34; Arth., Manual Rusts U. S. a. Canada, 1934, p. 7, fig. 10; Hunter, Journ. Arn. Arb. XVII, 1936, p. 34, tab. 176, fig. 7(2); Tranzschel, Consp. Ured. URSS, Moscow, 1939, pp. 62, 65.

Syn.: **Milesina vogesiaca** Syd., Ann. mycol. VIII, 1910, p. 491; Monogr. Ured. III, 1915, p. 476; Hirats., Monogr. Pucciniastreae, 1936, p. 96, tab. V, fig. 4, 5.

Uredo vogesiaca (Syd.) Sacc. et Trotter, in Sacc., Sylloge, XXI, 1912, p. 812.

B i o l. Hunter, l. c., 1936; Mayor, Bull. Soc. Neuchât. sci. natur.
186 LXIV, 1939, p. 16.

Spermagonia amphigenous, mostly epiphyllous on needles of current year, very abundant, immersed, inconspicuous, colorless, $154-241\mu$ wide

by 168—214μ high, spherical to slightly flask-shaped in section. Spermatia narrow-ellipsoid, 4—5 × 1.5—2.0μ.

Aecia hypophyllous on needles of current year, in two irregular rows, one on each side of midrib on slightly yellow-discolored areas of the tissue, white, cylindrical, 0.5—0.7 mm across, 0.6—1.0 mm high; peridia colorless, delicate, rupturing at the apex; peridial cells polygonal, vertically elongate, overlapping, in a single layer, 32—48 × 20—32μ; their outer wall smooth, inner wall verrucose or with coarse, short, irregularly orientated ridges. Aeciospores ellipsoid, ovoid, or globoid, mostly elongate, white, 32—46 × 24—30μ; spore wall thin (about 1μ), verrucose; warts irregular in outline, tapering to a blunt point, sometimes deciduous.

Uredia round or slightly elongate, 0.1—0.3 mm long, covered by the faintly brownish epidermis, scattered or loosely grouped on olive patches of the leaf; peridia hemispherical; peridial cells colorless, isodiametrically or irregularly polygonal, usually 8—15μ across; walls 0.5—1.5μ thick. Urediospores abundant, single, on short pedicels, obovoid or ellipsoid, 29—41 × 14—23μ (on an average, about 36 × 18μ), with very thin, smooth walls (Figure 20).

FIGURE 20. Milesia vogesiaca (Syd.) Faull on Polystichum lobatum (Sw.) Presl. Urediospores, × 600. (Orig.)

Telia hypophyllous and occasionally epiphyllous, forming on overwintered leaves, brown areas of indefinite extent. Teliospores usually fill the epidermal cells, occasionally also the guard cells, 1- to 50-celled, with vertical septa and one pore in the outer wall of each cell; teliospore cells 9—17 × 8—14μ, with smooth, thin, colorless walls.

Aecia on **Abies alba** Mill. in culture.

18. **Milesia whitei** Faull, Contr. Arn. Arb. II, 1932, p. 111, tab. V, fig. 20, a—d; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 62, 65.

Syn.: **Milesina Theissenii** Siemaszko, Ann. mycol. XXXI, 1933, p. 98.

Milesina Whitei (Faull) Hirats., Monogr.
187 Pucciniastreae, 1936, p. 124.

Milesina polystichi Grove, Journ. Bot. LIX, 1921, p. 109 (non **Milesia polystichi** Wineland).

Gloeosporium polypodii Aggery, pr. p. Bull. Soc. hist. natur. Toulouse, LXVIII, 1935, p. 123, 124, tab. color. VIII.

Spermagonia and aecia unknown.

Uredia 0.15—0.3 mm across, subepidermal, scattered or loosely grouped on greenish to brownish areas; peridia very delicate, hemispherical; peridial cells small, isodiametric or polygonal, at the base more or less elongate radially, walls thin (less than 1μ). Urediospores obovoid or ellipsoid, rarely subgloboid, 22—40 × 17—22μ (on an average, 30 × 19μ); walls thin (less than 1μ), rather sparsely and finely echinulate (Figure 21).

Teliospores on overwintered leaves, hypophyllous, on brown areas of indefinite extent, occasionally involving entire pinnae. Teliospores intraepidermal, at times filling the cells; uni- or pluricelled; cells 8—20 × 6—15μ.

Aecia probably on species of **Abies**. Uredio- and teliospores on **Polystichum aculeatum** (L.) Roth in Yugoslavia (Dalmatia), England, and France.

This species is differentiated from the preceding two by the echinulate urediospores. In the western states of North America on **Polystichum munitum** (Kaulf.) Presl is found **M. polystichi** Wineland with thick-walled urediospores while peridial cells and urediospores are more intensively echinulate.

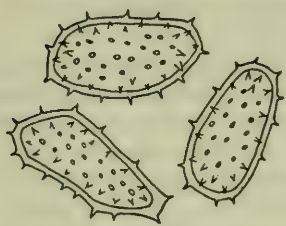


FIGURE 21. Milesia whitei Faull on Polystichum aculeatum (L.) Roth. Urediospores, × 600. (Orig.)

General distribution: western Europe, USSR (Caucasus).

Polystichum aculeatum (L.) Roth — CAUCASUS: W Transc. (near Sukhumi in Abkhazia, 1918, Siemaszko).

On **Phyllitis**

19. **Milesia scolopendrii** (Fuckel) Arth., Bull. Torrey Bot. Club. LI, 1924, p. 52; Faull, Contr. Arn. Arb. II, 1932, p. 113, tab. VI, fig. 22, a—c; Hunter, Journ. Arn. Arb. XVII, 1936, p. 33, tab. 176, fig. 2, 7 (4); p. 130, tab. 185, fig. 27, pl. 186, fig. 28, 29; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 62, 65.

Syn.: **Ascospora scolopendrii** Fuckel, Symb. myc., Zweiter Nachtrag., 1813, S. 19.

Uredo scolopendrii Schroet., Pilze Schlesien, 1887, S. 374 (quoad nomen); Trotter, Fl. Ital. Crypt. Ured., 1914, p. 453; Grove, Brit. Rust Fungi, 1914, p. 376, fig. 283.

Uredinopsis scolopendrii Rostr., Bot. Tidskr. XXI, 1897, p. 42; Hariot, Uréd., 1908, p. 256.

Milesina scolopendrii Jaap, Fungi select. exs. No. 571, 1912, Verh. Bot. Ver. Prov. Brand. LVI, 1914, S. 85; Syd., Monogr. Ured. III, 1915, p. 480; Fragoso, Fl. Iber. Ured. II, 1925, p. 282, 384, fig. 138; Sacc., Sylloge, XXIII, 1926, p. 846; Wilson, Trans. Bot. Soc. Edinb. XIV, 1934, p. 436; Hirats., Monogr. Pucciniastreae, 1936, p. 133.

Gloeosporium Nicolai Aggery, Bull. Soc. hist. natur. Toulouse, LXVIII,
188 1936, p. 107, fig. 97—122, tab. color. VI.

Biol. Hunter, l. c., 1936.

Spermagonia amphigenous, immersed, abundant, inconspicuous, colorless, flat, hemispherical to slightly flask-shaped in section, subcuticular, 120—128μ wide, 100—188μ high. Spermatia colorless, narrow-ellipsoid, 4—5 × 1.5—2.0μ.

Aecia hypophyllous on needles of current year in two irregular rows, one on each side of midrib, white, cylindrical, 0.4—0.5 mm across, 0.7—1.5 mm high; peridium colorless, delicate, rupturing at the apex; peridial cells angular, vertically elongate, overlapping, 28—56 × 20—36μ, with outer walls smooth and inner walls finely and densely warted, the warts arranged in short lines. Aeciospores ellipsoid, ovoid, or globoid, mostly elongate, white, 28—48 × 21—44μ; walls colorless, thin (about 1μ), very densely and rather coarsely verrucose with warts tapering to a blunt point and partly deciduous.

Uredia round, 0.1—0.3 mm across, subepidermal, scattered or loosely grouped, frequently in rows between the lateral veins on olive or brown areas of indefinite extent; peridium hemispherical, delicate; peridial cells isodiametric to somewhat elongate in the upper part of the peridium, radially elongate near base of peridium, with walls up to 1 μ thick. Urediospores on pedicels up to 16 μ long, obovoid or ellipsoid, 28—57 × 14—23 μ (averaging about 37 × 19 μ); spore wall 0.5—1.5 μ thick, quite strongly and rather sparsely echinulate (Figure 22).

Telia on overwintered leaves, hypophyllous (occasionally also epiphyllous) on brown areas of indefinite extent. Teliospores intraepidermal, sometimes completely filling the epidermal cells, also within the guard cells, 1- to 40-celled; cells 8—25 × 7—15 μ.

Basidiospores globoid or subgloboid, 6.0—7.5 μ across.

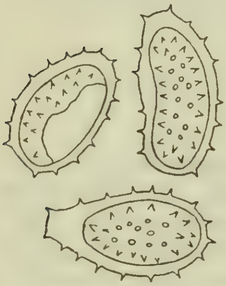


FIGURE 22. **Milesia scolopendrii** (Fuckel) Arth. on **Phyllitis scolopendrium** (L.) Newm. Urediospores, × 600. (Orig.)

Aecia on **Abies alba** Mill. and **A. concolor** (Gord.) Lindl. in culture. Uredio- and teliospores on **Phyllitis scolopendrium** (L.) Newm. (=**Scolopendrium vulgare** Smith). In Japan on **Phyllitis scolopendrium**, occurs **Milesia scolopendrii** var. **sublevis** Faull (l. c., p. 117, tab. VI, fig. 23) (= **Milesia sublevis** Hirats. f., l. c., p. 111), with short echinulations or verrucules on urediospore walls. According to Kamei (1933) aecia on **Abies mayriana** (quoted from Hiratsuka, 1936, p. 113).

General distribution: Europe (including the Caucasus).

On **Phyllitis scolopendrium** (L.) Newm. — EUROPEAN PART: M Dnp. ("Les na Vorskle" [Forest on the Vorskla"] (Brezhnev)); CAUCASUS: W Transc. (Kelassuri (Siemaszko), Tsebel'da (Voronov), near Sukhumi).

In experimental infections carried out by Hunter (l. c.) in England, teliospores sown on **Abies alba** and **A. concolor** produced aeciospores, which proved infective for **Phyllitis scolopendrium** but failed to infect **Blechnum spicant**, **Dryopteris spinulosa dilatata**, and **Polystichum angulare**.

189 2. Genus UREDINOPSIS Magn.

Magn., Atti Congr. Bot. Intern. Genova 1892, 1893, p. 167; Hirats., A Monograph of the Pucciniastreae, Mem. Tottori Agric. Coll. IV, 1936; Faull, Taxonomy and Geographical Distribution of the Genus Uredinopsis, Contr. Arn. Arb. Harvard Univ. XI, 1938; The Biology of Rusts of the Genus Uredinopsis, Journ. Arn. Arb. XIX, 1938, p. 402—439.

Spermagonia usually hypophyllous, colorless, hemispherical, or subgloboid, the rounded base deeply immersed into the leaf tissue, almost imperceptible on the leaf surface, devoid of ostiolar filaments, subcuticular (described as subepidermal in two East Asian species).

Aecia hypophyllous on leaves of current year (in one species on leaves of second to fifth year), conspicuous, white. Peridium colorless, irregularly

opening at the apex. Aeciospores white, in chains, verrucose; spores more coarsely warted on one side than on the other.

Uredia of one or two kinds (primary and secondary, or amphispores), hypophyllous, subepidermal. Peridium colorless, of one cell layer. Urediospores white. In primary uredia (II^1) peridium opens soon after formation, peridial cells thin-walled. Urediospores on very short pedicels, almost sessile; in some species urediospores subgloboid or broad-ellipsoid, smooth, verrucose or echinulate; in many species urediospores fusoid, ellipsoid, or obovoid, either tapered or, more often, finely pointed, smooth, or frequently with two opposing vertical rows of verrucules, straight or diagonal; two pores near each end of the spore; in both kinds (on **Adiantum**) spores surrounded by a colorless capsule. In secondary uredia (II^2) the peridia are mostly more compact, opening later, the peridial cells more thick-walled. Urediospores (amphispores) on elongate pedicels, rather irregularly shaped, usually polyhedral, at times ribbed or with wing-shaped projections or "antennae," smooth or more often finely and densely verrucose.

Teliospores appear in fall, subepidermal, occasionally also between parenchyma cells, usually hypophyllous, colorless, globoid, or broad-ellipsoid, smooth, vertically septate into 2, 4, and up to 8 cells, germinating after hibernation into four-celled basidia that pierce the epidermis.

According to observations aecia develop on Abies, and uredio- and teliospores on ferns. There are 26 known species. Of these, 13 species and 3 varieties are found in the western hemisphere (north of Mexico, 4 species south of the U. S. A., 3 species in Europe), 12 species in Asia, and one species in Africa. **Uredinopsis macrosperma**, although characteristic of all the regions mentioned, does not spread throughout the areas of distribution of its host — **Pteridium**; **U. struthiopteridis** is found in North America, Europe, and Asia, **U. filicina** — in Europe and Asia. Most numerous species are found in the eastern United States and eastern Asia, indicating the antiquity of the genus. In the USSR 8 species are known, of which 5 are confined to the Far East.

The geographical distribution of several species of **Uredinopsis** differs strikingly from that of their hosts. Thus, **U. filicina** (on **Dryopteris**
190 **phegopteris**), **U. hirosakiensis** (on **D. thelypteris**) and **U. kameiana** (on **Pteridium aquilinum**) are characteristic only of the eastern hemisphere; **U. atkinsonii** (on **Dryopteris thelypteris**), **U. phegopteridis** (on **D. linnaeana**), **U. mirabilis** (on **Onoclea sensibilis**), **U. osmundae** (on **Osmunda cinnamomea**, **O. claytoniana**, **O. regalis**), **U. aspera** (on **Pteridium aquilinum** var. **lanuginosum**) and **U. virginiana** (on **P. aquilinum** var. **pseudocaudatum**) are known only in the western hemisphere, although species of their hosts occur in both hemispheres. This is most significant in view of the primitivity of the genus **Uredinopsis** and of its distribution mainly in areas cf the ancient flora. It can be assumed that the ferns were widespread before any species of **Uredinopsis** had evolved, and even earlier, before any of the contemporaneous genera of rust fungi had appeared in the Temperate Zone.

It is doubtful whether species known only in eastern North America can be found in the USSR.

Key to Species of Genus **Uredinopsis**

I. Urediospores of the simple type (summer) apically mucronate rarely rounded, with 2 (seldom 4) longitudinal or anticlinal rows of warts on opposite sides of the spore, rarely almost smooth.
  A. Urediospores with colorless, thick, gelatinous capsule, the mucro disappearing in mature spores, occasionally remaining only at the base inside the capsule; amphispores not produced . . . . 1. **U. adianti** Kom.
  B. Urediospores without capsules.
    1. Urediospores apically mucronate.
      a. Amphispores not produced.
        * Mucro about 12μ long . . . . . 13. **U. osmundae** Magn.
        ** Mucro about 20μ long . . . 10. **U. phegopteridis** Arth.
      b. Amphispores produced.
        * Urediospores almost smooth with a broad-based conical mucro . . . . 11. **U. filicina** (Niessl) Magn.
        ** Urediospores with a thin narrow-based mucro.
        + Mucro usually about 5μ long . . . . 12. **U. mirabilis** (Peck) Magn.
        ++ Mucro on an average $5-10\mu$ long . . . . 3a. **U. longimucronata** Faull var. **acrostichoides** Faull(on **Athyrium acrostichoides**). . . . . 7. **U. atkinsonii** Magn. (on **Dryopteris thelypteris**) . . . . 16. **U. struthiopteridis** (Rostr.) Störmer (on **Matteuccia struthiopteris**).
        +++ Mucro on the averagé longer than 10μ . . . . 3. **U. longimucronata** Faull f. **cyclosora** Faull.
    2. Urediospores devoid of mucro.
      a. Urediospores usually pointed at the apex, rarely with a moderate mucro.
        * Amphispores not produced . . . . 14. **U. macrosperma** (Cooke) Magn.
        ** Amphispores produced.
        + Urediospores with 2 opposing rows of warts, the rest smooth . . . . 15. **U. kameiana** Faull.
        ++ Urediospores with $2-4$ vertical rows of warts and with scattered warts . . . . 4. **U. copelandi** Syd.
      b. Urediospores usually rounded at the apex.
        * Amphispores not produced . . . . 2. **U. athyrii** Kamei.
        ** Amphispores produced.
191 + Amphispores smooth or almost smooth . . . . 5. **U. daisenensis** Hirats.
        ++ Amphispores finely verrucose . . 17. **U. woodsiae** Kamei.

II. Urediospores of irregular shape, frequently broadening at the apex, smooth.
  A. Amphispores produced, more regularly shaped, obovoid, and thicker than primary urediospores. . . . . 6. **U. intermedia** Kamei.
  B. Amphispores not produced . . . . 9. **U. ossiformis** (**ossaeiformis**) Kamei.

III. Urediospores obovoid or ellipsoid, echinulate. Amphispores not produced.

A. Spores on the average about 26 × 16 μ . . . . 8. **U. hirosakiensis** Kamei et Hirats.
B. Spores on the average about 32 × 20 μ . . . . . . (**U. aspera** Faull).
C. Spores on the average about 43 × 17 μ . . . (**U. hashiokai** Hirats.).

On Adiantum

1. **Uredinopsis adianti** Kom. in Jacz., Kom., Tranz., Fungi Rossiae exs. No. 278, 1899; Sacc., Sylloge, XVI, 1902, p. 271; Syd., Monogr. Ured. III, 1915, p. 492; Hirats., Japan. Journ. Bot. III, 1927, p. 311; Journ. Soc. Agric. and Forestr. Sapporo, XX, 1928, p. 693; Journ. Japan. Bot. X, 1934, p. 472, fig. 10; Monogr. Pucciniastreae, 1936, p. 78; Faull, Contr. Arn. Arb. XI, 1938, p. 32, tab. I, fig. 1, a, b; VI, fig. 29, a—j; Tranzschel, Consp. Ured. URSS, Moscow, 1939, pp. 63, 68.

Biol. Kamei, Journ. Soc. Agric. a. Forestr. Sapporo, XXIV, 1933, p. 364 (var. nov.).

Spermagonia subcuticular, hemispherical to slightly conical, 70—165 μ across, 66—77 μ high. Spermatia 4.8—6.4 × 1.6—2.0 μ (after Kamei, in culture).

Aecia hypophyllous, on leaves of current year, in two rows, white, cylindrical, 0.5—0.25 mm across, up to 1.2 mm high; peridial cells with smooth outer walls, about 1 μ thick, inner walls densely and rather coarsely verrucose, 2—3 μ thick. Aeciospores subgloboid or ellipsoid, colorless, 17—26 × 15—20 μ (averaging about 22 × 18 μ); wall about 1 μ thick, densely and rather finely verrucose on one side, the other side almost smooth.

Uredia hypophyllous on yellowing areas, turning brown, scattered, 0.1—0.3 mm across, subepidermal; peridia hemispherical. Urediospores on very short pedicels, white, fusoid or elongate-ovoid, 19—54 × 8—15 μ, "with a filamentous mucro, 0—27 μ, on an average 14 μ; spores together with mucro covered by thick colorless capsule" (Faull); mucro invisible on mature spores apart from traces in the lower part; wall colorless, smooth, up to 1 μ thick, with 2 pores, one at each end (Figure 23).

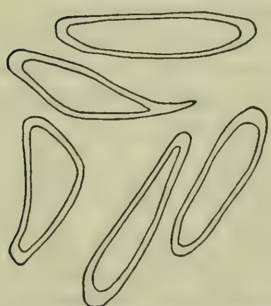


FIGURE 23. **Uredinopsis adianti** Kom. on **Adiantum pedatum** L. Urediospores, × 600. (Orig.)

192

Teliospores subepidermal, scattered or in loose groups, round or ellipsoid, 1- to 8-celled, mostly 4-celled, 18—38 × 14—25 μ; walls colorless, smooth, about 1 μ thick.

Capsule difficult to detect on urediospores; best seen on stained spores, around which it appears as a very delicate hyaline hood; mucro sometimes invisible. The peculiar structure of the wall in species of **Uredinopsis** on **Adiantum** was first recorded by Faull. Aecia on **Abies mayriana** Miyabe et Kudo were obtained in culture by Kamei in Japan. Uredio- and teliospores on **Adiantum pedatum** L. in Japan, Manchuria, and the USSR.

General distribution: eastern Asia.

On **Abies mayriana** Miyabe et Kudo — aecia in culture.

On **Adiantum pedatum** L. — FAR EAST: Uss.

On **Athyrium**

2. **Uredinopsis athyrii** Kamei, Trans. Sapporo Nat. Hist. Soc. XII, 1932, p.163; Hirats., Monogr. Pucciniastreae, 1936, p.75; Faull, Contr. Arn. Arb. XI, 1938, p. 37, tab. I, fig. 3, a, b; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 62, 67.

Biol. Kamei, Journ. Soc. Agric. a. Forestr. Sapporo, XXIV, 1933.

Spermagonia amphigenous, mostly hypophyllous, small, numerous, crowded in compact groups on pale areas, single or confluent, inconspicuous on the frond, barely noticeable, subcuticular in section, flat-conical or hemispherical, $37-77\mu$ wide. Spermatia elongate, colorless, smooth, $4.8-6.4 \times 1.6-2.4\mu$.

Aecia on leaves of current year, 0.2 — 0.7 mm across, up to 2 mm high, cylindrical; peridial cells polygonal or ellipsoid, colorless; inner wall coarsely verrucose, $2-4\mu$ thick, outer wall smooth, $1-2\mu$ thick. Aeciospores mostly obovoid or ellipsoid, $13-27.5 \times 12-23.5\mu$ (usually $21 \times 19.5\mu$); walls colorless, finely verrucose, about 1μ thick; contents colorless.

Uredia hypophyllous, on patches, occasionally on veins and petioles, circular, 0.1 — 0.5 mm across, in section more or less hemispherical, covered by a delicate peridium. Urediospores on very short pedicels, fusoid or oblong-ovoid, $21-42 \times 11.5-17.5\mu$ (usually $32 \times 13\mu$) (according to Faull $27 \times 12\mu$), rounded at the apex, sometimes with a very short terminal beak; walls 1μ thick, colorless, with 2 longitudinal rows of fine, densely arranged warts; contents colorless. Amphispores unknown.

Teliospores amphigenous, subepidermal, mostly hypophyllous, hemispherical to subgloboid, $15-37 \times 13-25\mu$, 1- to 5-celled, mostly 4-celled; wall 1μ thick, colorless.

Basidiospores subgloboid, $7-11\mu$ wide.

Spermagonia and aecia were obtained on leaves of **Abies mayriana** Miyabe et Kudo by Kamei from experimental sowing of overwintered teliospores. Uredio- and teliospores on leaves of **Athyrium filix-femina** Roth. var. **melanolepis** Makino. (=**A. melanolepis** (Franch. et Sav.) Christ.) in Japan on Hokkaido Island. The fungus may be anticipated in Sakhalin where forests of **Athyrium melanolepis** have been reported.

193 3. **Uredinopsis longimucronata** Faull f. **cyclosora** Faull, Contr. Arn. Arb. XI, 1938, p. 48, tab. II, fig. 8, a—d.

Spermagonia and aecia not accurately known (0 and 1 reported on **Abies lasiocarpa** (Hook.) Nutt. directly adjoining infected fern hosts).

Primary urediospores in hypophyllous, subepidermal sori on very short pedicels, ellipsoid or fusoid, $37-47 \times 11-17\mu$ (usually about 41μ), with filamentous mucro about 13μ; walls colorless, smooth, with 2 opposing rows of short, dense verrucae. Secondary urediospores in hypophyllous, subepidermal sori, developing later than the primary, on the same patches; peridia rather compact, opening late. Amphispores on elongate pedicels angular-obovoid or irregularly polyhedral, very frequently with wing-shaped projections, $25-28 \times 17-18\mu$ (usually $27 \times 18\mu$); walls thin and densely verrucose.

Teliospores amphigenous, mostly hypophyllous, subepidermal, intercellular, scattered or in groups, colorless, 1- to 6-celled, mainly 4-celled, subgloboid, $16-17\mu$ in diameter; walls colorless, smooth, about 1μ thick.

Spermagonia and aecia probably on Abies lasiocarpa (Hook.) Nutt. Uredio- and teliospores on **Athyrium cyclosorum** Rupr. in western Canada and in the northwestern U.S.A. From the main species — **U. longimucronata** Faull — the form **cyclosorum** is encountered in the eastern U.S.A. and in eastern Canada on **Athyrium angustum** (Willd.) Presl, distinguished by more elongate primary urediospores and larger amphispores.

It might be found in the Far East. **A. acrostichoides** (Sw.) Diels occurs in the Soviet Far East (Uss.). **A. filix-femina** Roth var. **cyclosorum** Rupr. ranges from Scandinavia to Japan.

4. **Uredinopsis copelandi** Syd., Ann. mycol. II, 1904, p. 30; Sacc., Sylloge, XVII, 1905, p. 30; Arth., N. Amer. Fl. VII, 1907, p. 116; Syd., Monogr. Ured. III, 1915, p. 30; Faull, Contr. Arn. Arb. XI, 1938, p. 39, tab. I, fig. 6, a—d; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 62, 67.

Spermagonia and aecia unknown.

Primary uredia hypophyllous, round, 0.1—0.5 mm across; peridium delicate. Urediospores abundant, on very short pedicels, ellipsoid, obovoid, or fusoid, 27—54 × 11—16 μ (averaging about 39 × 14 μ), blunt or pointed, rarely with a short mucro; spore wall colorless, with 2 opposite rows of short thickly set verrucae; frequently with additional warts in incomplete
194 vertical rows and scattered. Secondary urediospores in hypophyllous circular sori, developing after the primary sori, 0.1—0.4 mm in diameter; peridia rather delicate, opening late. Amphispores on elongate pedicels, angular-obovoid to irregularly polyhedral, 19—38 × 15—27 μ (on an average, about 26 × 20 μ), with projections and denticules; spore wall densely and finely verrucose, 2.0—2.5 μ thick (Figure 24).

Teliospores amphigenous, mostly hypophyllous, scattered, subepidermal, 1- to 6-celled, usually 4-celled.

On **Athyrium cyclosorum** Rupr. (= **A. filix-femina** var. **cyclosorum** Rupr.) in California. This species is frequently mixed with other species. Arthur annexes **Uredinopsis atkinsonii** to **U. copelandi** (North Amer. Fl. VII, 1925, p. 684), but on p. 819 (1927) indicates the occurrence of **U. longimucronata** f. **cyclosora.** The same author (Manual of the Rusts of the United States and Canada, 1934, p. 5) unites under the designation **Uredinopsis struthiopteridis** the following: **U. struthiopteridis, U. arthurii** Faull, **U. copelandi, U. longimucronata** (and f. **cyclosura** Faull), **U. ceratophora** Faull and **U. atkinsonii.** Hiratsuka (Monogr. Pucciniastreae, 1936, p. 53) refers to **U. copelandi** the same species as Arthur, apart from the first two (Figure 4 on Plate II — **Uredinopsis longimucronata** Faull f. **cyclosora** Faull). Morphological characteristics of **U. copelandi** and of other species have been elucidated by Faull (l. c., pp. 40, 60).

FIGURE 24. **Uredinopsis copelandi** Syd. on **Athyrium cyclosorum** Rupr. Urediospores, × 600. (Orig.)

In "Opredelitel' rastenii Dal'nevostochnogo kraya" (Key to Plants of the Far East), by V. L. Komarov and E. N. Klobukova-Alisova, **Athyrium cyclosorum** Rupr. is reported from the lower reaches of the Amur River.

5. **Uredinopsis daisenensis** Hirats., Monogr. Pucciniastreae, 1936, p. 69; Faull, Contr. Arn. Arb. XI, 1938, p. 40, tab. I, fig. 4, a, b.

Spermagonia and aecia unknown.

Primary urediospores very similar to those of **Uredinopsis athyrii** Kamei. Secondary uredia hypophyllous, round, 0.2 — 0.3 mm in diameter; peridium convex, colorless. Urediospores colorless, on pedicels up to 27 μ long, obovoid to ellipsoid, slightly angular, with inconspicuous edges, smooth or very faintly verruculose, 19 — 27 × 11 — 19 μ (average 22 × 15 μ); spore wall up to 1.5 μ thick (Figure 25).

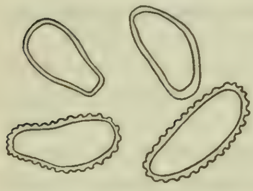


FIGURE 25. **Uredinopsis daisenensis** Hirats. on **Athyrium deltoideofrons** Mak. Urediospores, × 600. (Orig.)

Teliospores mostly hypophyllous, subepidermal,
195 colorless, subgloboid to ellipsoid, 2- to 4-celled, 16 — 24 × 16 — 20 μ; spore wall colorless, smooth, about 1 μ thick.

On species of **Athyrium** (**A. multifidum** Rosenst. (= **A. deltoideofrons** Mak.), **A. otophorum** (Miq.) Koidz., **A. rigescens** Mak., **A. vidalii** (Franch. et Sav.)) in Japan. Distinguished from **Uredinopsis athyrii** Kamei only by development of amphispores. Faull (l. c., p. 38) found the latter only on **Athyrium multifidum**, but held that amphispores might be found also on **A. melanolepis**; while **Uredinopsis daisenensis** should be referred to the synonym **U. athyrii**.

May possibly be found in the Far East.

6. **Uredinopsis intermedia** Kamei, Trans. Sapporo Nat. Hist. Soc. XII, 1932, p. 166; Hirats., Journ. Japan. Bot. X, 1934, p. 473, fig. 11 (var. nov.); Monogr. Pucciniastreae, 1936, p. 71; Faull, Contr. Arn. Arb. XI, 1938, p. 42, tab. I, fig. 5, a—d; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 62, 68.

Spermagonia hypophyllous on leaves of current year, few, noticeable only in sections, subepidermal, deeply immersed, globoid or subgloboid, 130 — 209 μ across, 120 — 187 μ high. Spermatia elongate, 5.6 — 6.7 × 1.9 — 2.4 μ.

Aecia on leaves of current year, hypophyllous, cylindrical, 0.2 — 0.4 mm in diameter, 0.6 — 1.2 mm high; peridial cells colorless, their outer walls smooth, 1 μ thick, inner walls 3 — 7 μ thick, finely and densely warted. Aeciospores subgloboid, 16 — 29 × 11.5 — 23.5 μ (usually 21 × 19.5 μ); walls thin, verrucose, except for a small smooth portion; contents colorless.

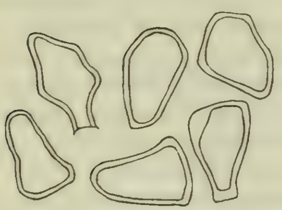


FIGURE 26. **Uredinopsis intermedia** Kamei on **Athyrium acrostichoides** (Sw.) Diels. Urediospores, × 600. (Orig.)

Primary uredia hypophyllous on brown discolored areas, 0.2 — 0.3 mm across, covered by delicate hemispherical peridia. Urediospores on very short pedicels of various shapes: rhomboid, tapering, ovoid, often with angular projections, 14.5 — 32 × 13 — 30 μ (usually 24 × 16 μ) (according to our measurements, 21 — 30.5 × 11 — 14.5 μ); walls 1 μ thick, at the corners thick, colorless, smooth (Figure 26). Secondary uredia develop late in fall, covered by a compact peridium usually opening in the spring.

Amphispores ovoid to prismatic, 17.5—24 × 13—19.5μ, usually on pedicels 7.5—37μ long; walls thicker, very finely verrucose, or smooth at the apex; contents colorless.

Teliospores subepidermal, amphigenous, mostly hypophyllous, intercellular, globoid to ellipsoid, usually 2- to 6-celled, 18.5—35.5 × 15—22μ; walls colorless, smooth, thin.

Basidiospores subgloboid, 7.5—11 × 5.5—9.0μ.

Uredio- and teliospores in Japan on **Athyrium acrostichoides** (Sw.) Diels and **A. pterorachis** H. Christ.

General distribution: USSR (Far East) and Japan.

On **Abies mayriana** Miyabe et Kudo — aecia in culture.

On **Athyrium acrostichoides** (Sw.) Diels — FAR EAST: Uss.

196 Urediospores (primary) and teliospores found by V. G. Tranzschel (14 Sept., 1929) in the Shkotovo District, in the basin of the Maikhe River, in the mountains near the village of Kharitonovka. The second host — **A. pterorachis** — is also encountered in the Far East.

By direct infection with germinating overwintered teliospores Kamei obtained aecia on leaves of current year of **Abies mayriana** Miyabe et Kudo, in Japan.

In the spermagonia stage the fungus is similar to the genus **Milesia**.

On **Dryopteris**

7. **Uredinopsis atkinsonii** Magn., Hedwigia, XLIII, 1904, S. 123, Taf. V, Fig. 1—7; Sacc., Sylloge, XVII, 1905, p. 269; Arth., N. Amer. Fl. VII, 1907, p. 117 (pr. p. inclus. **U. longimucronata** Faull); Syd., Monogr. Ured. III, 1915, p. 488 (pr. p. inclus. **U. longimucronata** Faull); Faull, Contr. Arn. Arb. XI, 1938, p. 57, tab. III, fig. 13, a—e, see note under **Uredinopsis copelandi**.

Biol. Fraser, Mycologia, V, 1913, p. 236.

Spermagonia and aecia like those of **U. mirabilis**.

Primary uredia hypophyllous, 0.1—0.4 mm across, covered by delicate peridium. Urediospores ellipsoid, obovoid to fusoid, 23—49 × 8—15μ (average 34 × 12μ), with filamentous mucro, 0—19μ long (usually 7—11μ); walls colorless, smooth, with two opposing vertical rows of thickly set warts. Secondary uredia hypophyllous, developing later than the primary, 0.1—0.4 mm across, covered by the late opening peridium. Amphispores obovoid to angular, 19—43 × 11—24μ (average about 26 × 11μ); walls colorless, 1.0—2.5μ thick, thicker at the corners, finely verrucose (Figure 27).

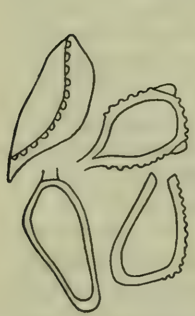


FIGURE 27. Uredinopsis atkinsonii Magn. on Dryopteris thelypteris A. Gray. Urediospores, × 600. (Orig.)

Teliospores hypophyllous, subepidermal, globoid, 1- to 8-celled, mostly 4-celled; walls thin, colorless, smooth.

Aecia on **Abies balsamea** (L.) Mill. in Nova Scotia. Uredio- and teliospores on **Dryopteris thelypteris** A. Gray in the eastern parts of North America.

Fraser (l. c.) has experimentally infected **Dryopteris thelypteris** with aeciospores from **Abies balsamea** (in Nova Scotia). The experiments mentioned by Faull

(Proc. Intern. Congr. Plant Sci., II, 1929, pp. 1736, 1739, 1743) were not performed with **Uredinopsis atkinsonii** in the present meaning, but with **U. longimucronata** Faull.

In the Far East and in Japan another species — **Uredinopsis hirosakiensis** Kamei et Hirats. — parasitizes on **Dryopteris thelypteris**.

8. **Uredinopsis hirosakiensis** Kamei et Hirats., ex Kamei, Trans. Sapporo Nat. Hist. Soc. XII, 1932, p. 164; Hirats., Monogr. Pucciniastreae, 1936, p. 84, tab. II, fig. 5; Faull, Contr. Arn. Arb. XI, 1938, p. 61, tab. III, fig. 14, a, b; Tranzschel, Consp. Ured. URSS, Moscow,
197 1939, p. 61, 67.

Biol. Kamei, l. c., 1932; Trans. Sapporo Nat. Hist. Soc. XIII, 1934, p. 153, fig. 1 — 3.

Spermagonia amphigenous, mostly hypophyllous, scattered on yellow discolored areas of the tissue, subcuticular, barely projecting above the surface, or slightly flattened, conical or subgloboid in section, 74 — 137μ across, 37 — 92.5μ high; honey-colored. Spermatia prismatic to prismatic-ellipsoid, 4.8 — 6.4 × 1.5 — 2.7μ.

Aecia mostly hypophyllous on leaves of current year on discolored areas, cylindrical, 0.2 — 0.3 mm in diameter, 0.6 — 1.2 mm high; peridial cells colorless, inner wall 2 — 4μ thick, finely and densely warted, outer wall thin, 1μ, smooth. Aeciospores globoid or obovoid, 15 — 26.5 × 11 — 17.5μ (usually, 20.5 × 18.5μ); spore wall colorless, thin, 1.0 — 1.5μ, sparsely warted, apart from a small smooth area; contents colorless.

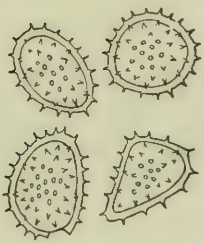


FIGURE 28. **Uredinopsis hirosakiensis** Kamei et Hirats. on **Dryopteris thelypteris** (L.) A. Gray. Urediospores, × 600. (Orig.)

Uredia hypophyllous on yellowing and browning areas, round, minute 0.1 — 1.3 mm across, yellowish, covered by a delicate flattened-subgloboid peridium. Urediospores white, ovoid to ellipsoid, 15.5 — 33 × 11 - 24.5μ (usually, 24 × 19μ); spore wall thin, 1μ, colorless, distinctly echinulate; contents colorless (Figure 28).

Teliospores amphigenous, subepidermal, spherical to ellipsoid, 2- to 4-celled, rarely pluricellular, colorless; spore wall thin. Basidiospores subgloboid, 11 — 7.5 × 7.5μ.

Uredio- and teliospores on leaves of **Dryopteris thelypteris** (L.) A. Gray.

The species in question is very close to the genus **Pucciniastrum**, as already noted by Kamei, and was retained in the genus **Uredinopsis** only on account of its parasitism on ferns and its hyaline urediospores.

General distribution: USSR (Far East) and Japan.

On **Abies mayriana** Miyabe et Kudo — aecia in culture.

On **Dryopteris thelypteris** (L.) A. Gray — FAR EAST: Uss. (rather frequent in the environs of the city of Voroshilov [Ussuriisk], and on the Murav'ev-Amurskii Peninsula; uredio- and teliospores (V. G. Tranzschel)). In Japan aecia were obtained by Kamei on **Abies mayriana** Miyabe et Kudo, after experimental infection with overwintered teliospores.

9. **Uredinopsis ossiformis** Kamei (sub U. ossaeiformis), Trans. Sapporo Nat. Hist. Soc. XII, 1932, p. 167; Hirats., Monogr. Pucciniastreae, 1936, p. 80; Faull, Contr. Arn. Arb. XI, 1938, p. 62, tab. III, fig. 15, a, b; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 62, 68.

Biol. Kamei, l. c., 1932.

Spermagonia hypophyllous, on leaves of current year, few, initially inconspicuous, later turning brown on yellowed areas, scattered subepidermally, deeply immersed, subgloboid, large, $154-270\mu$ across, $110-241\mu$ high. Spermatia ellipsoid to prismatic, $3.6-6.6 \times 1.2-2.3\mu$.

198 Aecia on leaves of current season, amphigenous, mostly hypophyllous, 0.2 — 0.2 mm across, up to 1 mm high; inner wall of peridium $3-5\mu$ thick, densely and finely verrucose, the verrucules mostly in short linear rows; outer wall smooth, about 1μ thick. Aeciospores ellipsoid to subgloboid, $21-30.5 \times 16-25\mu$ (frequently, $22 \times 18\mu$); wall colorless, $1-2\mu$ thick, finely verrucose except for a small smooth area; contents hyaline.

Uredia hypophyllous on yellowish patches, round, 0.1 — 0.3 mm in diameter, covered by hemispherical delicate peridium. Urediospores broadly wedge-shaped, at times abruptly widened at the apex, "bone-shaped," at other times angular, truncated at the apex or slightly rounded, occasionally subgloboid, $22.5-43 \times 12.5-22.5\mu$ (usually $35.5-16\mu$) (according to our measurements, $20-40 \times 12-18\mu$); spore wall colorless, 1.5μ thick, at the apical corners 3μ thick, contents hyaline (Figure 29).

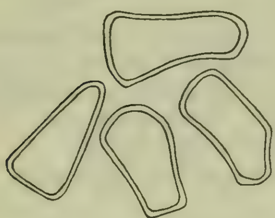


FIGURE 29. **Uredinopsis ossiformis** Kamei on **Dryopteris amurensis** H. Christ. Urediospores, × 600. (Orig.)

Teliospores connivent, subepidermal, amphigenous, mostly hypophyllous, sometimes deeply sunk in the parenchyma, intercellular, globoid to ellipsoid, longitudinally septate, 2- to 6-celled, mostly 4-celled, according to our measurements, $20-32 \times 14.5-23\mu$, according to other data $17-31 \times 15-27\mu$; spore wall colorless, smooth, thin.

Basidiospores subgloboid, $7.7-9.2 \times 5.5-7.4\mu$, colorless.

In the urediospore stage the fungus resembles **Milesia miyabei**, although the urediospores are on an average shorter. The immersed but not subcuticular spermagonia also place it near to **Milesia miyabei**, from which it is distinguished only by the arrangement of teliospores and their development in fall, and not in the spring. Uredio- and teliospores on **Dryopteris dilatata** A. Gray, **D. monticola** H. Christ., and **D. amurensis** H. Christ.

General distribution: USSR (Far East) and Japan.

On **Abies mayriana** Miyabe et Kudo — aecia in culture.

On **Dryopteris amurensis** H. Christ. (= **Aspidium spinulosum** var. **amurense** Milde) — FAR EAST: Uss. (Shkotovo District, basin of the Maikhe River, in mountains near the village of Kharitonovka, in September 1929, uredio- and teliospores (V. G. Tranzschel)).

On **D. dilatata** A. Gray — FAR EAST: Sakh. (Kuril Islands).

Aecia were obtained in Japan by seeding in the spring overwintered germinating teliospores on leaves of current season of **Abies mayriana** Miyabe et Kudo, **A. sachalinensis** Mast. and **A. firma** S. et Z.

10. **Uredinopsis phegopteridis** Arth., N. Amer. Fl. VII, 1907, p. 117, 685; Sacc., Sylloge, XXI, 1912, p. 609; Syd., Monogr. Ured. III, 1915, p. 487; Bell, Bot. Gaz. LXXII, 1924; p. 9, text. fig. 3—10, tab. I, fig. 1; tab. II, fig. 2—15; tab. IV, fig. 22; Hunter, Bot. Gaz. LXXXIII, 1927, p. 16; Arth., Manual Rusts U. S. a. Canada, 1934, p. 14, fig. 5; Hirats., Monogr. Pucciniastreae, 1936, p. 72; Faull, Contr. Arn. Arb. XI, 1938, p. 77, tab. 5, fig. 26, a—d; Tranzschel, Consp. Ured. URSS, Moscow, 1939,
199 p. 62, 67.

Biol. Fraser, Mycologia, V, 1913, p. 236; Faull, Journ. Arn. Arb. XIX, 1938, p. 412.

Spermagonia like those of **Uredinopsis mirabilis**.

Aecia similar to those of **Uredinopsis mirabilis**; aeciospores $19-28 \times 16-22\mu$ (average $22 \times 19\mu$).

Uredia hypophyllous, round, minute, 0.1—0.3 mm in diameter, covered by delicate peridium. Urediospores on very short pedicels, ellipsoid, obovoid, or fusoid, $27-51 \times 10-16\mu$, (average $36 \times 12\mu$), with filamentous mucro $0-46\mu$ long (average about 19μ); spore wall colorless, smooth with 2 opposing vertical rows of short, thickly set warts.

Teliospores subepidermal, 1- to 4-celled, mostly 4-celled.

Aecia on **Abies balsamea** (L.) Mill., uredio- and teliospores on **Dryopteris linneana** C. Christ. (= **Phegopteris dryopteris** Fée) in eastern North America. In the USSR the fungus is not found and its occurrence is unlikely irrespective of the widespread distribution of its second host. Apart from its generic characteristics the fungus is distinguished from the species **Hyalopsora aspidiotus**, which is common on the same ferns, by the shape and colorless contents of the urediospores.

Fraser (1913) obtained aecia in cultures on **Abies balsamea**. Faull (1938, pp. 412—414) performed successful infection experiments with aecia from **Abies balsamea** on **Dryopteris linneana** and vice versa.

11. **Uredinopsis filicina** (Niessl) Magn., Atti Congr. Bot. Intern. Genova 1892, 1893, p. 167, tab. IX, fig. 1—13; Diet., Ber. Deutsch. bot. Ges. XIII, 1895, S. 330, Taf. XXVI, Fig. 1—4; Fischer, Ured. Schweiz, 1904, S. 475, Fig. 310—311; Hariot, Uréd., 1908, p. 255, fig. 32; Liro, Ured. Fenn., 1908, p. 495; Bubák, Rostpilze Böhmens, 1908, S. 192, Fig. 48; Migula, Kryptog.-Fl. Deutschl. III, 1, 1910, S. 473, Taf. X 3, Fig. 6; Klebahn, Kryptogfl. M. Brandb. Va, 1914, S. 849, Fig. UI; Trotter, Fl. Ital. Crypt. Ured., 1914, p. 391, fig. 33, 99; Grove, Brit. Rust Fungi, 1914, p. 379, fig. 284, Syd., Monogr. Ured. III, 1915, p. 484; Fragoso, Fl. Iber. Ured. II, 1925, p. 276, fig. 136; Hirats., Monogr. Pucciniastreae, 1936, p. 73, tab. V, fig. a—e; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 61, 69.

Syn.: **Protomyces? filicinus** Niessl, in Rabenhorst, Fungi eur. 1659, 1873 (nomen).

Gloeosporium phegopteridii Patter, Rev. Mycol. II, 1880, p. 36; Sacc., Sylloge, III, 1884, p. 721.

Gloeosporium phegopteridii Frank, Krankh. Pflanz., 1880, S. 611; Sacc., Sylloge, X, 1892, p. 463.

Uredo polypodii f. **phegopteris** Winter, Pilze Deutschl. I, 1881, S. 253.

Gloeosporium Frankii Allescher, Pilze Deutschl. VII, 1901, p. 494.

Biol. Kamei, Journ. Soc. Agric. a. Forestr. Sapporo, XXIV, 1933, p. 364—365.

Spermagonia mainly hypophyllous on leaves of current year, subcuticular, slightly convex, occasionally conical, 73—118.5μ wide, 37—64.5μ high. Spermatia 4.8—6.4 × 1.9—2.4μ.

Aecia hypophyllous on leaves of current year, cylindrical, 0.2—0.5 mm
200 across, up to 1.3 mm high, white; outer wall of peridial cells smooth, 1.0—1.2μ thick; inner wall densely and rather coarsely verrucose, 3—6μ thick. Aeciospores broad-ellipsoid, ovoid, or subgloboid, white, 19—24 × 16—22μ (on an average, 21 × 17μ); spore wall densely and rather coarsely warted, colorless, 1.2μ thick.

Primary uredia hypophyllous on discolored spots, subepidermal, round, 0.1—0.3 mm in diameter; peridium colorless, delicate; peridial cells isodiametric to irregularly angular, somewhat elongate toward the peridial base. Urediospores white in mass, on very short pedicels, ellipsoid, obovoid, or fusoid, 24—46 × 8—13μ (on an average, 31 × 10μ), mucronate, narrowly conical at apex and broad at the base, 0—22μ long (on an average, 12μ); spore wall thin, less than 1μ, smooth, except for a few flat verrucules; in many spores lateral walls considerably thickened, up to 3μ. Secondary uredia develop later than the primary ones and resemble them but open late. Urediospores (amphispores) colorless, on long pedicels, obovoid, or irregularly angular, 14—30 × 8—22μ (on an average, 21 × 13μ), without wings or prongs, walls densely and finely warted, colorless, 1.0—1.5μ thick.

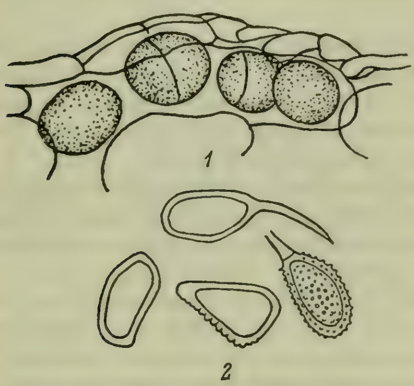


FIGURE 30. **Uredinopsis filicina** (Niessl) Magn.: 1 — on **Phegopteris vulgaris** Mett., teliospores (after Klebahn), 2 — on **Dryopteris phegopteris** (L.) C. Christ. Urediospores, × 600. (Orig.)

Teliospores scattered, usually hypophyllous, subepidermal, intercellular, subgloboid to ellipsoid; usually 2-celled, rarely 1-celled, 14—22μ across; spore wall colorless, about 1μ thick (Figure 30).

Uredio- and teliospores on **Dryopteris phegopteris** (L.) C. Christ. (= **Phegopteris vulgaris** Mett., **Nephrodium phegopteris** Baumg.) almost throughout Europe and in Japan.

On **Abies mayriana** Miyabe et Kudo — aecia in culture.

On **Dryopteris phegopteris** (L.) C. Christ. (= **Phegopteris vulgaris** Mett., **Nephrodium phegopteris** Baumg.) — EUROPEAN PART: Balt., Lad.-Ilm., V.-Kama, U. Dns.; FAR EAST: Uss., Sakh. (Kuril Is.).

With basidiospores from **Dryopteris phegopteris** Kamei obtained spermagonia and aecia on **Abies mayriana**.

On Onoclea

12. **Uredinopsis mirabilis** (Peck) Magn., Hedwigia, XLIII, 1904, S. 121, Taf. I, Fig. 1—13; Arth., N. Amer. Fl. VII, 1907, p. 115, pr. p.; 1925, p. 683, pr. p.; Bell, Bot. Gaz. LXXVII, 1924, p. 19, 27,

tab. IV, fig. 25, 26; Arth., Manual Rusts U. S. a. Canada, 1934, p. 3, pr. p., fig. 3; Hunter, Journ. Arn. Arb. XVII, 1936, p. 131, tab. 187, fig. 35; Faull, Contr. Arn. Arb. XI, 1938, p. 64, tab. V, fig. 22, a—d; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 61, 67.

Syn.: **Septoria mirabilis** Peck, Ann. Rep. N. Y. St. Mus. Nat. Hist.
201 XXV, 1873, p. 87.

Uredinopsis americana Syd., Ann. mycol. I, 1903, p. 325; Sacc., Sylloge, XVII, 1905, p. 269; Syd., Monogr. Ured. III, 1915, p. 486; Hirats., Monogr. Pucciniastreae, 1936, p. 56, pr. p.

Biol. Fraser, Mycologia, IV, 1912, p. 189; V, 1913, p. 236; VI, 1914, p. 25; Faull, Journ. Arn. Arb. XIX, 1938, p. 408.

Spermagonia hypophyllous on leaves of current season, subcuticular and, on the upper walls of the epidermal cells, colorless, concave in section, 58—123μ wide, 35—54μ high.

Aecia hypophyllous on leaves of current year, white, 0.2—0.3 mm across, 0.5—1.0 mm high; inner wall of peridial cells densely and rather coarsely warted, 2.5—3.0μ thick. Aeciospores broad-ellipsoid, ovoid, or subgloboid, white, 16—24 × 15—19μ (on an average, 21 × 17μ); outer walls densely and rather coarsely verrucose.

Primary uredia hypophyllous, subepidermal, 0.1—0.2 mm across. Urediospores ellipsoid, obovoid, or fusoid, 24—67 × 8—14μ (on an average, 40 × 11μ), with a filamentous mucro at apex, 0—19μ long (on an average, about 4μ long); spore wall colorless, smooth, except for 2 opposing vertical rows of short warts. Secondary uredia resemble the primary ones, but develop and open later. Amphispores angular-obovoid or irregularly polyhedral, 19—23 × 11—12μ (on an average, 21 × 10μ); spore wall colorless, thinly and densely verrucose (Figure 31).

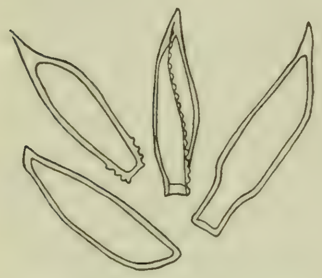


FIGURE 31. **Uredinopsis mirabilis** (Peck) Magn. on Onoclea sensibilis L. Urediospores, × 600. (Orig.)

Telia and teliospores as in other species. Teliospores usually 4-celled, but vary from 1- to 8-celled.

On **Onoclea sensibilis** L. in the eastern U. S. A. and in Canada; a most widespread species. Although the host is frequent in eastern Asia the fungus was not detected in the USSR or in Japan in spite of thorough searches.

Spermagonia and aecia were obtained by Fraser (l. c.) and Faull (l. c.) in cultures, on **Abies balsamea**.

On Osmunda

13. **Uredinopsis osmundae** Magn., Hedwigia, XLIII, 1904, p. 123, Taf. II, Fig. 8—16; Sacc., Sylloge, XVII, 1905, p. 270; Arth., N. Amer. Fl. VII, 1907, p. 115; Syd., Monogr. Ured. III, 1915, p. 487; Bell, Bot. Gaz. LXXVII, 1924, p. 7, 19, tab. III, fig. 20; tab. IV, fig. 23, 24; Moss. Ann. Botany, XL, 1926, p. 822, fig. 4—6, 21c, tab. XXXIV, fig. 27, 28, 41; Hunter, Bot. Gaz. LXXXIII, 1927, p. 16—18; Arth., Manual Rusts U. S. a. Canada, 1934, p. 3, fig. 2; Hirats., Monogr. Pucciniastreae, 1936, p. 74,

tab. III, fig. 2; Faull, Contr. Arn. Arb. XI, 1938, p. 68. Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 63, 68.

Biol. Fraser, Mycologia, V, 1913, p. 235; Faull, Journ. Arn. Arb. XIX, 1938, p. 414.

202 Spermagonia resemble those of **Uredinopsis mirabilis**.

Aecia resemble those of **Uredinopsis mirabilis**; aeciospores, $19-28 \times 16-22\,\mu$ (on an average, $22 \times 19\,\mu$).

Uredia resemble those of **Uredinopsis mirabilis**. Urediospores ellipsoid, obovoid, or fusoid, $24-65 \times 8-19\,\mu$ with filamentous mucro, $0-38\,\mu$ long (on an average, $11-13\,\mu$); spore wall colorless, smooth except for 2 opposing vertical rows of short verrucules up to $3\,\mu$ high. No amphispores (Figure 32).

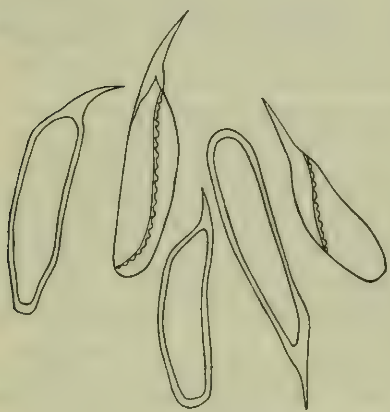


FIGURE 32. **Uredinopsis osmundae** Magn. on **Osmunda cinnamomea** L. Urediospores, × 600. (Orig.)

Telia and teliospores, as in the other species, usually 4-celled, in some samples 5- to 8-celled (varying from 1- to 8-celled).

Uredio- and teliospores on **Osmunda claytoniana** L., **O. cinnamomea** L., and **O. regalis** var. **spectabilis** (Willd.) A. Gray in eastern Canada and the U. S. A. The two-named plants are found in the Far East but the fungus, although searched for, was not detected.

Aecia on **Abies balsamea** Mill. were obtained by Fraser (1913) and Faull (1938) in infection experiments with teliospores from **Osmunda claytoniana**, **O. regalis** var. **spectabilis** and **O. cinnamomea**. Faull has experimentally established that the fungus from **O. claytoniana** and **O. regalis** var. **spectabilis** is not transferred onto **O. cinnamomea**, whereas the fungus from the latter plant infects all three plant species. Aeciospores obtained on **Abies balsamea** (by inoculation of teliospores from **O. claytoniana**) failed to infect **Onoclea sensibilis**, **Matteuccia struthiopteris**, **Athyrium angustum**, and **Dryopteris**.

On **Pteridium**

14. **Uredinopsis macrosperma** (Cooke) Magn., Hedwigia, XLIII, 1904, S. 122; Dietel ex E. Mayor, Mém. Soc. Neuchât. sci. natur. V, 1913, p. 553, fig. 63; Syd., Monogr. Ured. III, 1915, p. 491; Arth., N. Amer. Fl. VII, 1925, p. 684, pr. p.; Dodge, Bothalia (Pretoria), II, part Ia, 1926, p. 163; Hunter, Bot. Gaz. LXXXIII, 1927, p. 16, fig. 2; Arth., Manual Rusts U. S. a. Canada, 1934, p. 5, fig. 6, pr. p.; Hirats., Monogr. Pucciniastreae, 1936, p. 77, tab. II, fig. 2; Faull, Contr. Arn. Arb. XI, 1939, p. 85, tab. IV, fig. 19, a–f; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 63, 68, pr. p.

Syn.: **Uredo macrospermum** Cooke, Grevillea, VIII, 1879, p. 71.

Uredo macrosperma Cooke ex Sacc., Sylloge, VII, 1888, p. 853.

Uredinopsis pteridis D. et H., ex Dietel, Ber. Deutsch. bot. Ges. XIII, 1895, S. 331, Taf. XXVI, Fig. 10, 11; Jaczewski, Hedwigia, XXXIX, 1900, S. (130), Fig. 3; Sacc., Sylloge, XVI, 1902, p. 271; Arth., N.Amer. Fl. VII, 1907, p. 116, pr. p.; Syd., Monogr. Ured. III, 1915, p. 490, pr. p.; Weir a. Hubert, Amer. Journ. Bot. IV, 1917, p. 328, fig. 1, 2; Hirats., Monogr. Pucciniastreae, 1936, p. 61, pr. p., tab. III, fig. 1.

Aecidium pseudobalsameum D. et H., Erythea, VII, 1899, p. 98.

Peridermium pseudobalsameum (D. et H.) Arth. et Kern, Bull. Torrey Bot. Club, XXXIII, 1906, p. 430.

Biol. Weir a. Hubert, l. c., 1917.

203 Spermagonia hypophyllous on 2 — 5-year old leaves, abundant, colorless, immersed, almost round, concave in section, subcuticular, 100 — 159 μ wide, 85 — 110 μ high, on an average about 127 × 98 μ.

Aecia hypophyllous on 2 — 5-year old leaves, white, cylindrical, 0.2 — 0.5 mm across, up to 2 mm high; peridium colorless, brittle, opening at the apex; peridial cells polygonal, vertically elongate, more or less overlapping, 27 — 54 × 13 — 27 μ; outer wall smooth, 1.2 — 1.5 μ thick, inner wall rather densely and coarsely warted, 7 — 13 μ thick. Aeciospores broad ellipsoid, ovoid, or subgloboid, white, 16 — 27 × 14 — 21 μ (on an average, about 21 — 23 × 17 — 18 μ), spore wall densely and rather coarsely warted, colorless, 1.2 — 2.0 μ thick. In some specimens sporelike bodies are frequently found showing small, more or less eccentric recesses and thick walls; apparently, modified peridial cells.

Uredia hypophyllous, scattered, pustular, mostly round, 0.1 — 0.5 mm across, occasionally elongate, up to 1 mm long; peridium convex, colorless, rather compact, usually opening sideways; peridial cells isodiametrically or irregularly polygonal, obovoid, or fusoid, 22 — 70 × 8 — 21 μ (on an average, 40 × 13 μ), but greatly varying, averaging in diverse samples 30 — 50 × 11 — 17 μ, rounded or pointed at apex; wall colorless, smooth except for 2 opposing vertical rows of short thickly set verrucules; wall 0.7 — 1.2 μ thick, with 2 pores, one on each side (Figure 33).

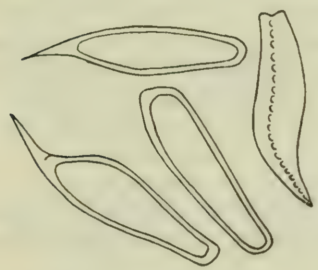


FIGURE 33. **Uredinopsis macrosperma** (Cooke) Magn. on **Pteridium aquilinum** (L.) Kühn. Urediospores, × 600. (Orig.)

Teliospores amphigenous mostly hypophyllous, subepidermal, scattered or loosely grouped in one layer, colorless, subgloboid, or ellipsoid, mostly 4-celled, but fluctuating from 1- to 4-celled and, at times, to 8-celled, 19 — 35 × 16 — 27 μ; spore wall colorless, smooth, about 1 μ thick; occasionally the spore cells dissociate.

Aecia on **Abies amabilis** (Dougl.) Forb., **A. concolor** (Gord.) Lindl. and **A. grandis** Lindl. in western North America. Uredio- and teliospores on **Pteridium aquilinum** (L.) Kühn. For differentiation between this widely distributed species and **Uredinopsis kameiana** see text on the latter. Two species clearly distinguished by the echinulate urediospores have so far been described on **Pteridium**: **Uredinopsis aspera** Faull (l. c., p. 79, tab. IV, fig. 18, a, b) on **Pteridium aquilinum** var. **lanuginosum**, in California, British Columbia, and the Hawaian Islands, and **U. hashiokai** Hirats. f. (Monogr. Pucciniastreae, 1963, p. 82, tab. III, fig. 3; Faull, l. c., p. 81, tab. IV, fig. 17, a, b) from Taiwan.

General distribution: western Europe, USSR (Siberia), China,
204 Japan, Africa, North and South America.

On **Abies amabilis** (Dougl.) Forb. and on other species of Abies — in western North America (aecia).

On **Pteridium aquilinum** (L.) Kühn — EUROPEAN PART: V.-Kama. (Molotov [Perm] Region: Il'inskoe village); W SIBERIA: Alt. (Kolyvanskoe, Tigerek); FAR EAST: Uss. (Maritime Territory), Ze.-Bu. (Amur Region: Pashkovo).

On **P. aquilinum** (L.) Kühn var. **japonicum** Nakai — FAR EAST: Sakh. (Sakhalin Island).

The connection of aecia on **Abies grandis** with the fungus on **Pteridium aquilinum** var. **lanuginosum** (Bong.) Fern. was established by experimental infection (Weir and Hubert, l. c.).

15. **Uredinopsis kameiana** Faull, Contr. Arn. Arb. XI, 1938, p. 82, tab. IV, fig. 20, a—d.

Syn.: **Uredinopsis pteridis** auct. pr. p. non Dietel et Holway, Syd., Monogr. Ured. III, 1915, p. 490, pr. p., tab. XXII, fig. 166; Kamei, Ann. Phytopathol. Soc. Japan. II, 3, 1930, p. 207, fig. 1—5, 7—8; Hirats., Monogr. Pucciniastreae, 1936, p. 61, pr. p.

Biol. Kamei, l. c., 1930.

Spermagonia mostly hypophyllous on leaves of current season, numerous, punctate, honey-yellowish in the beginning, reddish-brown later, subcuticular, lenticular or slightly conical, 66—132 μ wide, 37—66 μ high. Spermatia 4.5—6.7 × 1.6—2.8 μ.

Aecia mostly hypophyllous on leaves of current season, white, cylindrical, 0.3—0.5 mm in diameter, 1.0—1.5 mm high; peridial cells in single layer, polygonal, vertically elongated, 19—38 × 11—19 μ; outer wall smooth, 1.0—1.2 μ thick, inner wall 2.2—2.5 μ thick, densely and rather coarsely warted. Aeciospores subgloboid or broad-ellipsoid, white, 16—22 × 14—19 μ (on an average, 19 × 15 μ); wall densely and rather coarsely warted, except for one spot almost smooth; colorless, 1.0—1.2 μ thick.

Primary uredia hypophyllous, subepidermal, scattered, not abundant, blistery, round to linear, 0.2—1.0 mm long; peridium convex, colorless, very delicate; peridial cells isodiametric or irregularly polygonal, 8—16 × 6—12 μ, walls not thinner than 1 μ. Urediospores colorless, on very short pedicels, ellipsoid, obovoid, or fusoid, at times narrowly elongate at the base, 27—54 × 12—16 μ (on an average, about 37 × 12 μ), blunt or pointed; wall colorless, up to 1 μ thick; smooth, except for 2 opposing vertical rows of short, thickly set verrucules. Secondary uredia hypophyllous, subepidermal, scattered or in groups, round to linear, 0.2—1.5 mm long; peridium convex, colorless, delicate, opens late; peridial cells isodiametric or irregularly polygonal, 8—16 × 6—12 μ, walls up to 1.5 μ thick. Amphispores colorless, white, on long pedicels, angular-obovoid or irregularly polygonal, 22—43 × 14—23 μ (on an average, about 28 × 17 μ); spore wall colorless, densely verruculose, 1.5—4.0 μ thick (Figure 34).

FIGURE 34. Uredinopsis kameiana Faull on Pteridium aquilinum (L.) Kühn. Urediospores, × 600. (Orig.)

Telia scattered, amphigenous. Teliospores subepidermal, intercellular,
205 scattered or loosely aggregated in one layer, colorless, subgloboid, or broad-ellipsoid, 2- to 4-celled, rarely unicellular, 20—30 × 18—25 μ; spore wall colorless, smooth, about 1 μ thick; spore cells occasionally dissociating.

Aecia on **Abies mayriana** Miyabe et Kudo — in culture. Uredio- and teliospores on **Pteridium aquilinum** (L.) Kühn. Faull has separated **Uredinopsis kameiana** from **U. macrosperma** because the former has amphispores, while the aecial stage is produced on another host plant. A similar species was described by Faull from North America on **Pteridium aquilinum** var. **pseudocaudatum** and designated **Uredinopsis virginiana**. In the collections of V. G. Tranzschel there is not a single specimen of **U. kameiana** among the numerous specimens of **Uredinopsis** on **Pteridium**; in the herbarium of the Botanical Institute of AN SSSR (Division of Sporophytes) there are only specimens collected by V. L. Komarov, in August, 1913, near Voroshilov, where Tranzschel found only **Uredinopsis macrosperma**.

General distribution: USSR (Far East); China, Japan.

On **Abies mayriana** Miyabe et Kudo — aecia in culture.

On **Pteridium aquilinum** (L.) Kühn — FAR EAST: Uss. (Maritime Territory: Voroshilov).

Connection of the aecia on **Abies mayriana** with the fungus on **Pteridium aquilinum** was established by Kamei in cultures.

16. **Uredinopsis struthiopteridis** (Rostr.) Störmer, Bot. Notiser, 1895, p. 81; Dietel, Ber. Deutsch. bot. Ges. XIII, 1895, S. 331, Taf. XXVI, Fig. 5—9, 12—13; Sacc., Sylloge, XIV, 1899, p. 290; Arth., N. Amer. Fl. VII, 1907, p. 116, pr. p.; Liro, Ured. Fenn., 1908, p. 500; Klebahn, Kryptogfl. M. Brandb. Va, 1914, S. 850, 904; Syd., Monogr. Ured. III, 1915, p. 485, tab. XXI, fig. 165; Arth., Manual Rusts U. S. a. Canada, 1934, p. 4, fig. 4; Hirats., Monogr. Pucciniastreae, 1936, p. 60, pr. p., tab. II, fig. 3; Faull, Contr. Arn. Arb. XI, 1938, p. 96, tab. V, fig. 24, a—d; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 61, 67.

Biol. Fraser, Mycologia, V, 1913, p. 234; Klebahn, Ztschr. Pflanzenkr. XXVI, 1916, S. 258, Fig. 1; Kamei, Journ. Soc. Agric. a. Forestr. Sapporo, XXIV, 1933, p. 364; Faull, Journ. Arn. Arb. XIX, 1938, p. 407.

Spermagonia hypophyllous on leaves of current year, inconspicuous, round, colorless, immersed, concave in section, subcuticular, 71—129 μ wide, 45—58 μ high, on an average, 94 × 50 μ. Spermatia 1.5—2.0 × 4.6 μ.

Aecia hypophyllous on leaves of current year in two rows, white, cylindrical, 0.2—0.3 mm across, to 1 mm high; peridial cells in one layer, polygonal, vertically elongate, 24—40 × 11—24 μ, outer walls smooth, 1.2—1.3 μ thick, inner walls densely and rather coarsely warted, 3.0—3.5 μ thick. Aeciospores broad-ellipsoid, ovoid, or subgloboid, white, 18—24 × 15—19 μ, densely and rather coarsely warted on one side, and finely
206 verrucose on the other; wall 1.0—1.5 μ thick.

Primary uredia hypophyllous, subepidermal, scattered on patches, pustular, round or somewhat elongate, 0.1—0.3 μ across; peridium convex, colorless, delicate; peridial cells isodiametric or irregularly polygonal, 8—18 × 6—11 μ, wall about 1 μ thick. Urediospores colorless, on very short

pedicels, ellipsoid, obovoid, or fusoid, $27-54 \times 10-17\mu$ (on an average, about $37 \times 13\mu$), with filamentous mucro, $0-21\mu$ (on an average, about 6μ); walls smooth except for 2 opposing vertical rows of short, thickly set verrucules, up to 1μ thick, with 2 pores at each end. Secondary uredia hypophyllous, subepidermal, developing on the same patches but later than the primary sori, round, 0.1 — 0.3 mm in diameter; peridium convex, colorless, rather firm, opening late; peridial cells isodiametric or irregularly polygonal, $8-16 \times 6-11\mu$, wall up to 2.2μ thick. Amphispores colorless, on elongate pedicels, angular-obovoid or irregularly polyhedral, $18-40 \times 14-27\mu$ (on an average, about $27 \times 18\mu$) with rounded or faceted corners; walls colorless, finely and densely verrucose, $1-4\mu$ thick, thicker at the corners (Figure 35).

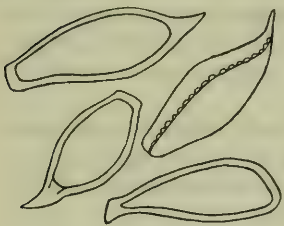


FIGURE 35. **Uredinopsis struthiopteridis** (Rostr.) Störmer on **Matteuccia struthiopteris** (L.) Todaro. Urediospores, ×600. (Orig.)

Telia scattered, amphigenous, mostly hypophyllous. Teliospores subepidermal, intercellular, scattered or loosely gathered in one layer, colorless, subgloboid or ellipsoid, usually 4-celled, divided crosswise, but varying from 1- to 4-celled, occasionally, to 7-celled, $25-36 \times 14-24\mu$, with one pore on the outer wall of each cell; wall smooth, about 1μ thick.

Uredio- and teliospores on **Matteuccia struthiopteris** (L.) Todaro; aecia on species of **Abies** (**A. alba**, **A. cephalonica**, **A. balsamea**, **A. mayriana**) in culture.

General distribution: Europe, Asia, (USSR: Siberia; Japan), North America.

On **Matteuccia struthiopteris** (L.) Todaro (= **Struthiopteris germanica** Willd.) — EUROPEAN PART: Bal., Lad.-Ilm., U. Dns., V.-Kama; CAUCASUS: W Transc., E Transc.; E SIBERIA: Ang.-Say.; FAR EAST: Uss., Sakh.

Aecia were produced in cultures by Fraser and Faull in Canada on **Abies balsamea**, by Klebahn in Europe on **A. alba** and **A. cephalonica**, and by Kamei in Japan, on **Abies mayriana**.

On **Woodsia**

17. **Uredinopsis woodsiae** Kamei, Trans. Sapporo Nat. Hist. Soc. XII, 1932, p. 162; Hirats., Monogr. Pucciniastreae, 1936, p. 67, tab. II, fig. 6; Faull, Contr. Arn. Arb. XI, 1938, p. 100, tab. V, fig. 25, a–d; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 61, 67.

Biol. Kamei, l.c., 1932.

Spermagonia amphigenous, mostly hypophyllous on leaves of current
207 season, subcuticular, lenticular, or flattened-conical, barely protruding over the leaf surface, $37-66.5\mu$ high, $92-137\mu$ wide. Spermatia prismatic, colorless, $4.0-5.6 \times 1.6-2.4\mu$.

Aecia usually hypophyllous, on leaves of current year, white, cylindrical, mostly 1 mm long, 0.15 mm across; peridial cells $22-37 \times 15-26\mu$, slightly tessellate; inner walls warted, about 4μ thick, outer walls smooth, about 1μ thick. Aeciospores globoid or ellipsoid, densely and finely verrucose, $15-28 \times 14-22\mu$ (average $20 \times 17\mu$); walls colorless, $1.0-1.5\mu$ thick.

Primary uredia hypophyllous, subepidermal, pustular, round, 0.2 — 0.5 mm across; peridium convex, colorless; peridial cells irregularly polygonal, $8-16\times 6-11\mu$, less than 1μ thick. Urediospores colorless, on short pedicels, obovoid, ellipsoid, or fusoid, rounded at the apex; according to Kamei with occasional very short beaks, $24-41\times 12-18\mu$, on an average about $31\times 15\mu$; walls colorless, about 1μ thick, smooth except for 2 opposing rows of short thickly set verrucules. Secondary uredia hypophyllous, subepidermal, developing later on the same patches as the primary sori, round, 0.2 — 0.5 mm across; peridium convex, colorless, firm, opening late; peridial cells isodiametric or irregularly polygonal, $8-16\times 6-11\mu$; walls $1.0-2.5\mu$ thick. Amphispores colorless, on pedicels up to 18μ long, ellipsoid, obovoid, subgloboid, or faceted, $22-38\times 11-19\mu$ (on an average, about $28\times 14\mu$); some spores with one or several longitudinal ridges; walls colorless, finely verrucose, $1.0-1.2\mu$ thick.

Telia scattered, amphigenous, mostly hypophyllous. Teliospores subepidermal, intercellular, scattered or loosely grouped in a single layer, colorless, globoid or ellipsoid, 2 — 4-celled, rarely unicellular, $18-29\times 16-27\mu$; walls colorless, smooth, about 1μ thick.

Aecia on **Abies mayriana** in culture. Uredio- and teliospores on **Woodsia polystichoides**, in the USSR (Far East) and in Japan.

On **Abies mayriana** Miyabe et Kudo — aecia in culture.

On **Woodsia polystichoides** Eat var. **nudiuscula** Hook. — FAR EAST: Sakh. (Sakhalin Island).

The connection between the aecia on **Abies mayriana** and the fungi on **Woodsia polystichoides** was established in cultures (Kamei).

3. Genus HYALOPSORA P. Magn.

P. Magn., Ber. Deutsch. bot. Ges. XXIX, 1901, S. 582; Syd., Monogr. Ured. III, 1915, p. 493; Hirats., Monogr. Pucciniastreae, 1936, p. 157–180.

Spermagonia mostly hypophyllous, yellow, immersed, lenticular, without ostiolar filaments, subepidermal, developing either in the second year after infection (as in **H. aspidiotus**), or in the same year (as in **H. aculeata**).

Aecia hypophyllous, round or oblong with a well-developed peridium. Aeciospores catenulate, contents yellow, developing (in **H. aspidiotus**) in the
208 third year after infection.

Uredia with very delicate, discrete (barely discernible) peridium, subepidermal; peridial cells flat. Urediospores yellow, produced singly, on short pedicels; walls almost smooth, inconspicuously verrucose, rarely echinulate. Thin- and thick-walled urediospores are encountered in the majority of species; thin-walled urediospores develop at the beginning of summer on young leaves, gradually replaced by thick-walled (amphispores); pores hardly perceptible on thin-walled spores, while evident on the thick-walled ones. The paraphyses surrounding the urediospores mentioned by some authors apparently represent the styles consisting of the basal, intermediate, and peridial cells (see E. H. Moss. The Uredo Stage of Pucciniastreae. Ann. Bot., XL, 1926, pp. 813 — 847).

Teliospores intracellular, intraepidermal, longitudinally dividing into 2 or more cells set in one or two layers, more or less filling the epidermal cells; walls smooth, colorless, thin, with one apical pore, rarely discernible.

Urediospores are produced throughout the summer and, in H. aculeata, also on overwintered leaves. Teliospores develop in the beginning of summer on young leaves, in H. aculeata on overwintered leaves; they germinate in the spring after a short rest period. In species in which aecia are known they develop on Abies; uredio- and teliospores — on ferns.

Nine species are known: three species in Europe, of which two are common to the USSR, Japan, and North America; and one species in Europe and Algeria; one species is characteristic of North America and Chile, 5 species — of eastern Asia. Within the USSR 3 species are known. In areas devoid of wild Abies the fungi are maintained from year to year by the thick-walled urediospores; usually no teliospores are produced.

Key to Species of Hyalopsora

I. Amphispores thick-walled, up to 5μ, conspicuous.
   A. On Cystopteris, Woodsia, etc. . . . 1. H. polypodii (DC) Magn.
   B. On Dryopteris . . . . 2. H. aspidiotus (Peck) Magn.
   C. On Athyrium . . . . 3. H. hakodatensis Hirats.
   D. On Coniogramma . . . . 5. H. yamadana Hirats.
II. Amphispores thin-walled, less than 2μ, or unknown.
   A. On Blechnum . . . . 4. H. aculeata Kamei.
   B. On Cheilanthes, Notholaena, Cryptogramma, etc. . . . . 6. H. cheilanthis (Peck) Arth.
   C. On Adiantum . . 7. H. adianti-capilli-veneris (Magn.) Syd.

On Cystopteris, Woodsia

1. **Hyalopsora polypodii** (DC) Magn., Ber. Deutsch. bot. Ges. XIX, 1901, S. 582; XXVII, 1909, S. 320, Taf. XIV, Fig. 1, 2; Fischer, Ured. Schweiz, 1904, S. 474, Fig. 309; Arth., N. Amer. Fl. VII, 1907, p. 112; 1925, p. 682; 1927, p. 819; Hariot, Uréd., 1908, p. 496; Bubák, Rostpilze Böhmens, 1908, S. 191; Migula, Kryptog.-Fl. Deutschl. III, 1, 1910, S. 472, Taf. XE, Fig. 5; Grove, Brit. Rust Fungi, 1913, p. 375, fig. 280; Klebahn, Kryptogfl. M. Brandb. Va, 1914, S. 859, Fig. W2; Trotter, Fl. Ital. Crypt. Ured., 1914, p. 390; Syd., Monogr. Ured. III, 1915, p. 496; Fragoso, Fl. Iber. Ured. II, 1925, p. 286, fig. 140; Hirats.
209 et Uemura, Trans. Tottori Soc. Agric. Sci. IV, 1932, p. 15; Arth., Manual Rusts U. S. a. Canada, 1934, p. 11, fig. 17; Hirats. Monogr. Pucciniastreae, 1936, p. 162, tab. VI, fig. 2—6; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 61—63.

Syn.: Uredo linearis β polypodii Pers., Syn. fung., 1801, p. 217.

Uredo polypodii DC, Fl. franç. VI, 1815, p. 81; Sacc., Sylloge, VII, 1888, p. 857, pr. p.

Pucciniastrum (Thecopsora) polypodii Diet., Hedwigia, XXXVIII, 1899, S. (260).

Uredinopsis polypodii (Pers.) Liro, Ured. Fenn., 1908, p. 496.

Pucciniastrum (Thecopsora) filicum Diet., Engler's bot. Jahrb. XXVII, 1899, S. 567, Taf. VII, Fig. 6; Sacc., Sylloge, XVI, 1902, p. 320.

Hyalopsora filicum Diet., Engler's bot. Jahrb. XXXVII, 1905, S. 105; Diet., Ann. mycol. V, 1907, p. 76; Syd., Monogr. Ured. III, 1915, p. 498.

Hyalopsora asplenii-Wichurae Diet., Ann. mycol. VI, 1908, p. 228; Sacc., Sylloge, XXI, 1912, p. 599; Syd., Monogr. Ured. III, 1915, p. 499.

Biol. Dietel, Ann. mycol. IX, p. 530; Bartholomew, Bull. Torrey Bot. Club, XLIII, 1916, p. 195, fig. 1—3; Moss, Ann. Bot. XL, 1926, p. 816, text fig. 2, 21B, tab. XXXIV fig. 1, 25, 26.

Spermagonia and aecia unknown.

Uredia hypophyllous and petiolicolous, scattered, round to ellipsoid, orange-yellow, covered by indistinct peridium of small colorless cells. Urediospores of two kinds, with yellow contents. 1) oblong-ellipsoid, clavoid, pyriform, often irregular, angular or even flexed, 22—30 (35) × 8—16 (20) μ; spore wall colorless, 1.0—1.5 μ thick, evenly covered by inconspicuous warts, with 4 equatorial, indistinct pores; 2) amphispores short-ellipsoid, slightly angular and irregular, 22—29—(38) × (17)—20—22—(29) μ; spore wall colorless, thicker than in spores of the first kind, about 2—5 μ; warts smaller, dispersed at approximately 2 μ intervals; spores with 6—8 readily perceptible pores; spore forms intermediate between the two described are also encountered.

Telia found in the spring, hypophyllous, on yellow-brownish patches of indefinite extent. Teliospores intraepidermal, often filling the cells, sometimes in two layers, round or angular due to reciprocal pressure, dividing crosswise along the axis into 2 or several cells, 14—18 μ across; walls thin, colorless, with one pore at the upper end (Figure 36).

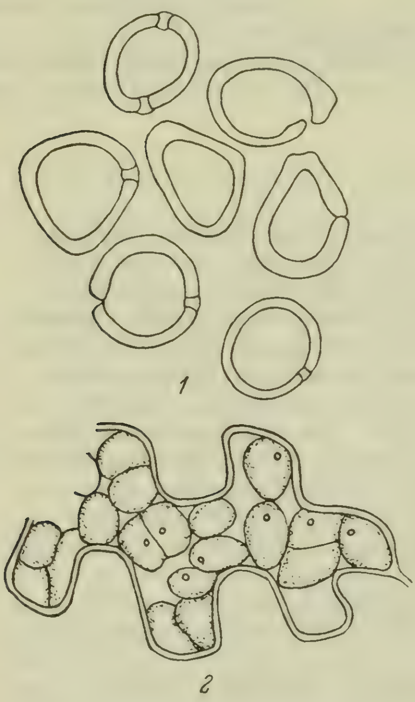


FIGURE 36. **Hyalopsora polypodii** (DC) Magn. on **Cystopteris fragilis** (L.) Bernh.:

1 — Urediospores, × 600. (Orig.); 2 — teliospores. (After Klebahn)

Spermagonia and aecia probably on species of **Abies**; still unknown. Uredio- and teliospores on species of **Cystopteris** in Europe, Asia, and North America, on species of **Woodsia** in North America and the USSR. Hiratsuka added to the species **H. polypodii** described by Dietel the species **H. filicum** and **H. asplenii-wichurae**, and indicated the existence in Japan of **H. polypodii** on species of **Athyrium, Cryptogamma, Cystopteris, Diplazium, Dryopteris, Matteuccia,** and on **Woodwardia orientalis**. Dietel proved that the fungus is maintained by the overwintering thick-walled urediospores. In the USSR the fungus is widespread in the uredial stage.

General distribution: Europe, Asia, North America.

On **Cystopteris fragilis** (L.) Bernh.— EUROPEAN PART: Dv.-Pech. (Puya River in the Shenkursk District), Lad.-Ilm. (S Karelian ASSR: Shcheliki;

Leningrad Region), Balt. (Estonian SSR, Latvian SSR), U. V. (Moscow
210 Region, Yaroslavl' Region), V.-Kama (Kazan), U. Dnp. (Belorussian SSR: Belostok Region[1] (Kuznitsa)), V.-Don (Syzran area: Bogorodskoe village), Crimea (Chatyrdag), L. Don (Saratov); CAUCASUS: W Transc. (Mt. Ryuka in Abkhazia, the village of Cholur in Svanetiya), E Transc. (Georgian SSR: Bakuriani); W SIBERIA: Irt. (Ulu-tau Mts.), Alt. (Sobach'e natural boundary area in Altai); FAR EAST: Sakh. (Kuril Is.); CENTRAL ASIA: Balkh. (Talass Ala-Tau), Pam.-Al. (Modmskoe Gorge in the Zeravshan Mts.), Tien Shan (Chimgan).

On **Woodsia obtusa** (Spr.) Torr. — St. Petersburg, 1880, in the Regel and Kesselring Garden on cultivated plants.

On **Woodsia glabella** R. Br. — EUROPEAN PART: Dv.-Pech. (Shchugor River — right affluent of Pechora).

On Dryopteris

2. **Hyalopsora aspidiotus** (Peck) Magn., Ber. Deutsch. bot. Ges. XIX, 1901, S. 582; Grove, Brit. Rust Fungi, 1913, p. 374, fig. 279; Syd., Monogr. Ured. III, 1915, p. 495, tab. XXII, fig. 167; Arth., N. Amer. Fl. VII, 1917, p. 112; 1925, p. 681; 1927, p. 819; Moss, Ann. Botany, XL, 1926, p. 816—821, text fig. 1, 3, 21 A, tab. XXXIV, fig. 2, 22, 23; Hunter, Bot. Gaz. LXXXIII, 1927, p. 11, text fig. 1, pl. IV, fig. 32; Hirats., Trans. Tottori Soc. Agric. Sci. II, 1930, p. 62; Arth., Manual Rusts U. S. a. Canada, 1934, p. 10, fig. 16; Wilson, Trans. Bot. Soc. Edinb. XIV, 1934, p. 431; Hirats., Monogr. Pucciniastreae, 1936, p. 138, tab. VII, fig. 1; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 62—63.

Syn.: **Uredo polypodii** β **polypodii-dryopteridis** Moug. et Nestl. ex DC, Fl. franç. VI, 1815, p. 81.

Uredo aspidiotus Peck, Ann. Rep. N. Y. St. Mus. XXIV, 1872, p. 88; Diet., Oesterr. bot. Ztschr. XLIV, 1894, S. 46; Sacc., Sylloge, XI, 1895, p. 228.

Pucciniastrum aspidiotus Karst., Mycol. Fenn. IV, 1879, p. 143; Diet., Hedwigia, XXXVIII, 1899, S. (260).

Caeoma aspidiotus Peck, Bull. Torrey Bot. Club, X, 1883, p. 62.

Melampsorella aspidiotus Magn., Ber. Deutsch. bot. Ges. XIII, 1895, S. 288, Taf. XXIII, Fig. 1—7.

Hyalopsora polypodii-dryopteridis (Moug. et Nestl.) Magn., Hedwigia, XLI, 1902, S. (224); Fischer, Ured. Schweiz, 1904, S. 472, Fig. 308; Sacc., Sylloge, XVII, 1905, p. 268; Bubák, Rostpilze Böhmens, 1908, S. 191, Fig. 47; Hariot, Uréd., 1908, p. 244, fig. 31; Migula, Kryptog.-Fl. Deutschl. III, 1, 1910, S. 471, Taf. XE, Fig. 3, 4; Trotter, Fl. Ital. Crypt. Ured., 1914, p. 389, fig. 32, 98; Klebahn, Kryptogfl. M. Brandb. Va, 1914, S. 857 (non S. 904), Fig. W1.

211 **Uredinopsis polypodii-dryopteridis** (Moug. et Nestl.) Liro, Ured. Fenn., 1908, p. 498.

Peridermium pycnoconspicuum Bell, Bot. Gaz. LXXVII, 1924, p. 25, fig. 35—37.

[1] [Since 1944 W part is in Poland and E part constitutes Grodno Region, USSR.]

Biol. Klebahn, Ztschr. Pflanzenkr. XV, 1905, S. 99; XXVI, 1916, S. 260–261; Bubák, Centrbl. Bakteriol, II. Abt. XVI, 1906, S. 156; Weir a. Hubert, Phytopathol. VIII, 1918, p. 37–38; Mayor, Bull. Soc. Neuchât. sci. natur. XLVII, 1923, p. 67–73; L, 1925, p. 82–84; LI, 1926, p. 66–67; Bell, Bot. Gaz. LXXVII, 1924, p. 21–26, fig. 1, 2, tab. IV, fig. 21, 27, 28; Pady, Ann. Botany, XLIX, 1935, p. 71–93, text fig. 1–54.

Spermagonia appear on second-year leaves in circular spots, hypophyllous, lenticular in section, 311–496μ wide and 86–117μ high (on an average, 432 × 102μ), under the slightly raised epidermis, with a densely interlacing mycelium at the basis; spermatophores septate, slightly slanting toward the center. Spermatia oblong, 5.1–8.7 × 2.4–3.9μ.

Aecia on third-year leaves, hypophyllous, on yellow patches, round or elongate, 0.5–0.8 mm across, up to 1 mm long and 1 mm high, brownish-yellow; peridium colorless or brownish; peridial cells rhombic in section, tessellate, outer walls 4–5μ thick, smooth, inner walls 6–8μ thick, warted. Aeciospores globoid or broad-ellipsoid, 21–25 × 16–19μ; walls colorless, thin, very finely and densely verruculose.

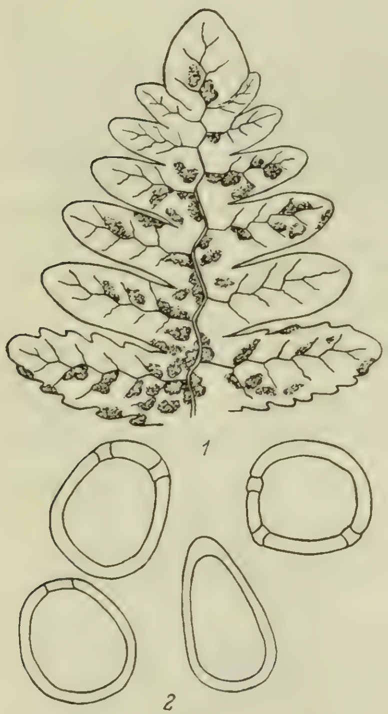


FIGURE 37. **Hyalopsora aspidiotus** (Peck) Magn. on **Dryopteris linnaeana** H. Chr.:

1 – infected leaf, × 4; 2 – urediospores, × 480. (Orig.)

Uredia amphigenous, scattered, round, orange to yellow, covered by a peridium of flattened cells pressed against the epidermis. Urediospores, with yellow contents, are of two kinds: 1) elongate, ovoid, or subpyriform, frequently irregular, 29–34 (48) × (16) 20–26μ; walls colorless, thin, 1.0–1.5μ, covered with inconspicuous warts, with 4 indistinct equatorial pores; 2) (= amphispores) from broad-ellipsoid to polygonal, 36–56 (72) × (27) 32–40μ; walls thick, up to 4μ, colorless, almost smooth, with 6–8 distinct, scattered pores.

Teliospores develop in the spring in the epidermal cells, frequently filling them, in 1–2 layers, round or angular due to reciprocal pressure, about 25μ long, 21–35μ across, longitudinally and crosswise divided into 3–5 cells; walls colorless, thin.

Spermagonia and aecia on species of **Abies**. Spermagonia appear in the year following the year of infection, and aecia in the same year. Uredio- and teliospores on **Dryopteris linnaeana** C. Chr. (= **Nephrodium dryopteris** Mich.) and **D. robertiana** (Hoffm.) C. Chr. Uredia appear in the summer after infection with aeciospores and develop throughout the host's growth period. Teliospores develop in the spring on young leaves and immediately germinate; usually, in the absence of **Abies** species no teliospores are detected (Figure 37).

Artificial culture of the fungus is not always successful; thus, Bubák (1906) and Klebahn (1905) failed to infect the experimental plants. In other experiments Klebahn obtained (1916) spermagonia on **Abies alba** Mill. in the year following infection. In his report of these experiments and in an earlier one referring to Fraser's experiments (Kryptogfl. M. Brandb., Va,
212 1914, S. 104) Klebahn confused **H. aspidiotus** with **Uredinopsis phegopteridis** Arth., found in North America also on **Dryopteris linnaeana**. Mayor (1923, 1925, 1926) noticed that on **Abies alba** aecia develop on leaves of the third year, and obtained urediospores on **Dryopteris linneana** from inoculations of aeciospores; on **Abies**, inoculations of basidiospores yielded spermagonia within the year, and aecia within 2 years. In North America, Bell (1924) found on third-year leaves of **Abies balsamea**, near **Hyalopsora aspidiotus**, aecia which he described under the name **Peridermium pycnoconspicuum**; inoculation with aeciospores led to development of urediospores on **Dryopteris linnaeana**. Weir and Hubert (1913) assumed that the fungus is transferred by overwintering urediospores. According to Pady the teliospore-forming mycelium overwinters in the rootstock of the host plant. Aecia are found on **Abies alba** Mill. in Switzerland, and on **A. balsamea** (L.) Mill. in Canada; no aecia are found in the USSR.

General distribution: Europe, Asia, North America.

On **Dryopteris linnaeana** C. Chr. — EUROPEAN PART: Kar.-Lap. (Khibiny Mts., Karelian ASSR), Dv.-Pech. (Arkhangel'sk Region: between the Onega and Vodla rivers, Shenkursk), Lad.-Ilm (Karelian ASSR; Leningrad Region), Bal. (Estonian SSR, Latvian SSR, Lithuanian SSR), U. V. (Moscow and Rybinsk areas), V.-Kama (Kirov, Kotel'nich), U. Dnp. (Smolensk), U. Dns. (Lvov area); CAUCASUS: W Transc. (former Artvin Subregion (now Turnil)); W SIBERIA: Ob (Tobol'sk, Narym Subregion), Irt. (Isha R.), Alt. (Kolyvanskoe village); E SIBERIA: Ang.-Say. (Lake Mozharskoe (in the Sayans?) Balagansk District); FAR EAST: Kamch, Sakh., Ze.-Bu. (Bureya Mts. on the Amur), Uss.

On **Dryopteris robertiana** (Hoffm.) C. Chr. — FAR EAST: Ze.-Bu. (Stolbovoi, Amur Region), Uss. (Voroshilov area).

On Athyrium

3. **Hyalopsora hakodatensis** Hirats. ex Hirats. a. Uemura, Trans. Tottori Soc. Agric. Sci. IV, 1932, p. 20, 25, fig. 2; Hirats., Monogr. Pucciniastreae, 1936, p. 171, tab. VII, fig. 3; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 62, 63.

Spermagonia and aecia unknown.

Uredia amphigenous, mostly epiphyllous, scattered or in groups, round or oblong, small, 0.18 — 0.4 mm across, pulverulent, orange to yellow, producing faint spots; peridium indistinct, of small cells flattened onto the
213 epidermis. Urediospores with yellow contents, of two kinds. 1) ellipsoid, prismatic, or ovoid, $20 - 27.5 \times 12.5 - 16.5\,\mu$; walls colorless, thin, $0.8 - 1.2\,\mu$; very finely verrucose, with 4 hardly perceptible equatorial pores. 2) Amphispores angular, semigloboid or ovoid, $15 - 30 \times 12.5 - 20\,\mu$; walls thick, $1.2 - 3.8\,\mu$, at the corners up to $4.5\,\mu$ thick, with 4 — 6 scattered pores (Figure 38).

Telia amphigenous, mostly hypophyllous. Teliospores intraepidermal, globoid or elongate, frequently angular, 2- to many-celled (mostly 2- to 5-celled), $15-36\mu$ across; walls colorless, smooth, thin, 1μ.

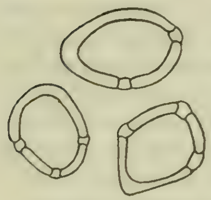


FIGURE 38. **Hyalopsora hakodatensis** Hirats. on **Athyrium acrostichoides** (Sw.) Diels. Urediospores, × 600. (Orig.)

Hiratsuka indicated the presence of rudimentary clavate paraphyses in the uredia, not mentioning peridia. In collections from the Far East Tranzschel noted (under the laterally opening pores covered by the epidermis) a tissue of minute polygonal cells, doubtless belonging to the peridium.

Uredio- and teliospores on **Athyrium acrostichoides** (Sw.) Diels in Japan and the USSR.

On **Athyrium acrostichoides** (Sw.) Diels — FAR EAST: Uss. (near Okeanskaya (thin-walled urediospores, 7 July), the Maikhinskoe forestry in the Shkotovo District (thick-walled urediospores, 14 September)).

On Blechnum

4. **Hyalopsora aculeata** Kamei, Trans. Sapporo Nat. Hist. Soc. XII, 1932, p.124, fig.1—3; Hirats. a. Uemura, Trans. Tottori Soc. Agric. Sci. IV, 1932, p.22,25; Hirats., Monogr. Pucciniastreae, 1936, p.172, tab.VI, fig.1.

Biol. Kamei, l.c., 1932.

Spermagonia on needles of current year, scattered on yellow discolored spots, 0.3 — 0.5 mm high. Spermatia colorless, prismatic-ellipsoid, $6.5-8.0 \times 3.2-3.6\mu$.

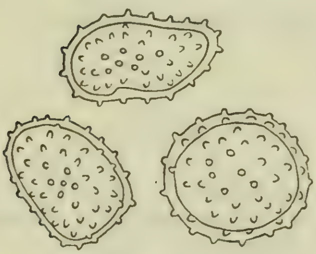


FIGURE 39. **Hyalopsora aculeata** Kamei on **Blechnum spicant** Wither var. **nipponicum** Miyabe et Kudo. Urediospores, × 600. (Orig.)

Aecia on needles of current year; peridium colorless. Aeciospores with orange-yellow contents.

Uredia on needles of current season and on overwintered ones, scattered on yellowish-brown or greenish spots, round, small, golden-yellow to golden-brown, covered by a compact peridium; develop from June till November. Urediospores globoid, ellipsoid, or ovoid, $30-49 \times 20-35\mu$; walls finely echinulate, $1-2\mu$ thick; contents orange to yellow (Figure 39).

Telia on overwintered needles. Teliospores intraepidermal, usually 2- to 7-celled, globoid, ellipsoid, or irregular, $20-60 \times 15-30\mu$; walls thin, about 1μ, colorless, smooth.

Uredio- and teliospores on **Blechnum spicant** Wither var. **nipponicum** Miyabe et Kudo (Sakhalin). Aecia are produced on needles of **Abies mayriana** Miyabe et Kudo soon after infection (Kamei, 1932).

The fungus occupies an intermediate place between the genera **Hyalopsora** and **Milesia**, resembling the latter in several characteristics and

214 distinguished from it by the orange-yellow contents of the urediospores. In Japan (Honshu), Hiratsuka described **Milesina blechnicola** (Bot. Mag., XLVIII, 1934, p. 40) from the same host. According to the author, this fungus is similar to **Hyalopsora aculeata** Kamei and differentiated by somewhat fewer, colorless urediospores and smaller uredia. However, the presence on a single host of two close species referred to one genus is doubtful.

On **Abies mayriana** Miyabe et Kudo — aecia in culture.

On **Blechnum spicant** Wither var. **nipponicum** Miyabe et Kudo — FAR EAST: Sakh. (Sakhalin Island).

On Coniogramma

5. **Hyalopsora yamadana** Hirats. ex Hirats. a. Uemura, Trans. Tottori Soc. Agric. Sci. IV, 1932, p. 19, 24, fig. 1; Hirats., Monogr. Pucciniastreae, 1936, p. 177, tab. VII, fig. 4; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 63, 64.

Spermagonia and aecia unknown.

Uredia amphigenous, mostly epiphyllous, scattered or in groups, round or elongate, small, 0.15 — 0.4 mm across, orange-yellow, surrounded by paraphyses (?). Urediospores with orange contents, of two kinds: 1) ovoid, ellipsoid, or prismatic, 22.5 — 37.5 × 15.0 — 22.5 μ; walls colorless, thin, about 1 μ, clearly verrucose, with 4 indistinct pores. 2) Amphispores, globoid to ellipsoid, frequently angular, 20.0 — 32.5 × 17.5 — 22.5 μ; walls colorless, thick, 1.5 — 3.0 μ, with 3 — 7 scattered pores.

Teliospores unknown.

On **Coniogramma fraxinea** Diels — in Japan (Hokkaido, Honshu). In the USSR the fungus may be found in the Far East — in the Maritime Territory and on Sakhalin Island.

On Cryptogramma

6. **Hyalopsora cheilanthis** (Peck) Arth. in N Amer. Fl. VII, 1907, p. 113; 1925, p. 682; 1927, p. 819; Sacc., Sylloge, XXI, 1912, p. 600; Syd., Monogr. Ured. III, 1915, p. 500; Arth., Manual Rusts U. S. a. Canada, 1934, p. 11, fig. 18; Tranzschel, Consp. Ured. URSS, Moscow, p. 63, 64.

Syn.: **Caeoma cheilanthis** Peck, Bull. Torrey Bot. Club, X, 1883, p. 62.

Hyalopsora pellaeicola Arth., Bull. Torrey Bot. Club, XXXIII, 1906, p. 30; Hirats., Monogr. Pucciniastreae, 1936, p. 175.

Spermagonia and aecia unknown.

Uredia amphigenous, scattered, irregularly circular or elongate, 0.3 — 0.7 mm across, golden-yellow; peridium very delicate and scarcely visible, thin. Urediospores globoid

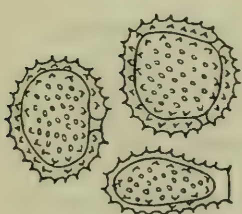


FIGURE 40. **Hyalopsora cheilanthis** (Peck) Arth. on **Pellaea** sp. Urediospores, × 600. (Orig.)

or obovoid - globoid, 22 — 30 × 16 — 22 μ; walls thin, 0.8 — 1.5 μ, finely verrucose or even echinulate - verrucose; pores indistinct, equatorial (Figure 40).

Teliospores intraepidermal, globoid, 4-celled, 15 — 20 μ across.

On species of **Cheilanthes**, **Pellaea**, and **Notholaena** in the U. S. A. and in Chile; on **Cryptogramma stelleri** Prantl (**Pellaea gracilis** Hook.)
215 in the U. S. A. (Iowa, Michigan, Wisconsin, Montana). The latter plant species occurs in the USSR in the Urals, in western and eastern Siberia.

On Adiantum

7. **Hyalopsora adianti-capilli-veneris** (Magn.) Syd., Ann. mycol. I, 1903, p. 248; Sacc., Sylloge, XVII, 1905, p. 268; Hariot, Uréd., 1908, p. 391; Migula, Kryptog.-Fl. Deutschl. III, 1, 1910, S. 472; Trotter, Ital. Crypt. Ured., 1914, p. 391; Syd., Monogr. Ured. III, 1915, p. 497; Fragoso, Fl. Iber. Ured. II, 1925, p. 287, fig. 141; Hirats., Monogr. Pucciniastreae, 1936, p. 174; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 63, 64.

Syn.: **Uredo polypodii** γ? **adianti-capilli-Veneris** DC in Fl. franc. VI, 1815, p. 81.

Uredo adianti-capilli-Veneris Magn., Ber. Deutsch. bot. Ges. XX, 1902, S. 612.

Spermagonia and aecia unknown.

Uredia hypophyllous, scattered on browning spots along the veins, rounded or elliptical, 0.2 — 0.4 mm across, yellow; peridium indistinct, of minute cells adhering to the epidermis. Urediospores globoid, ellipsoid, or elongate-ovoid, 20 — 34 × 15 — 25 μ; walls colorless, minutely verrucose, with 4 indistinct pores. The difference between the thin- and thick-walled urediospores is rather insignificant: in the former the wall is about 1 μ, in the latter about 2 μ thick (Figure 41).

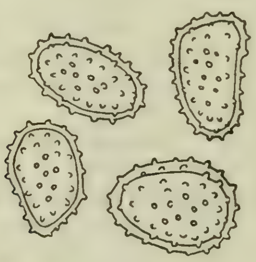


FIGURE 41. **Hyalopsora adianti-capilli-veneris** (Magn.) Syd. on **Adiantum capillus-veneris** L. Urediospores, × 600. (Orig.)

Teliospores intraepidermal, 1- to 4-celled, $12-20\mu$ high, up to 25μ wide, individual cells $9-12\mu$ across; walls colorless, 1μ thick.

On **Adianthum capillus-veneris** L. in France, Italy, Spain, Algeria, and Iran. In the USSR the host occurs in the Crimea, the Caucasus, and Soviet Central Asia.

4. Genus MELAMPSORELLA Schroet.

Schroet., Hedwigia, XIII, 1874, S. 85; Syd., Monogr. Ured. III, 1915, p. 432; Hirats., Monogr. Pucciniastreae, 1936, p. 199.

Spermagonia amphigenous, producing small rounded orange spots, superficial, subcuticular, hemispherical, with flat bases, devoid of ostiolar
216 filaments.

Aecia cylindrical, orange-yellow; peridium colorless, irregularly erumpent; peridial cells with verrucose walls. Aeciospores in chains with intermediate cells, from globoid to ellipsoid or ovoid, warted; walls colorless; contents orange-yellow.

Uredia subepidermal, covered by peridium; peridium thin, hemispherical, rupturing centrally at the apical pore; peridial cells smooth, polygonal. Urediospores yellow or orange-yellow, produced singly, on very short pedicels, ellipsoid or subgloboid, echinulate.

Teliospores intraepidermal, unicellular, occasionally dividing longitudinally into 2 cells, in varying number in each epidermal cell, globoid or, following reciprocal pressure, polyhedral; walls smooth, colorless, thin; contents colorless or pale yellow.

Aecia on **Abies** in summer. Teliospores develop in the spring and immediately germinate into 4-celled basidia. Uredio- and teliospores developing on diffuse mycelium overwinter in the host's roots.

Two species are known: **M. symphyti** ranging throughout Europe and Transcaucasia, and **M. cerastii**, in Europe, Asia, and North America.

Key to Species of **Melampsorella**

I. Aecia on diffuse perennial mycelium inducing enhanced development of shoots which bear aecia on all needles and are shed at the end of summer. Uredio- and teliospores on species of Stellaria, Cerastium, and on other plants of the family. **Caryophyllaceae**, subfamily **Alsinoideae** . . . . 1. **M. cerastii** (Mart.) Winter.

II. Aecia on local mycelium infecting single needles (leaves) of current year and developing soon after infection (within a month); uredio- and teliospores on species of **Symphytum** . . . . 2. **M. symphyti** (DC) Bubák.

On Caryophyllaceae

1. Melampsorella cerastii (Mart.) Winter, Hedwigia, XIX, 1880, S. 56; Schroeter, Kryptog.-Fl. Schlesien, III, 1, 1887, S. 366; Sacc., Sylloge, VII, 1888, p. 596; Liro, Ured. Fenn., 1908, p. 490; Arth., Manual Rusts U. S. a. Canada, 1934, p. 20, fig. 31; Hunter, Journ. Arn. Arb. XVII, 1936, fig. 10; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 177, 182.

Syn.: **Uredo cerastii** Mart., Prodr. fl. Mosquaensis, 1812, p. 231.

Uredo pustulata β **Uredo cerastii** Pers., Synops. fung. 1801, p. 219.

Melampsorella caryophyllacearum (Link) Schroet., Hedwigia, XIII, 1874 S. 85; Fischer, Ured. Schweiz, 1904, S. 516, Fig. 322, 326; Hariot, Uréd., 1908, p. 266, fig. 36, 37; Bubák, Rostpilze Böhmens, 1908, S. 211, Fig. 59; Migula, Kryptog.-Fl. Deutschl. III, 1, 1910, S. 489, Taf. XIB, Fig. 4; Grove, Brit. Rust Fungi, 1913, p. 360, fig. 269, 270; Klebahn, Kryptogfl. M. Brandb. Va, 1914, S. 821, 902, Fig. Q1; Trotter, Fl. Ital. Crypt. Ured., 1914, p. 428; Fragoso, Fl. Iber. Ured. II, 1925, p. 252, fig. 123—126; Hunter, Bot. Gaz. LXXXIII, 1927, p. 7—8, tab. I, fig. 1—4; tab. II, fig. 5; Hirats., Monogr. Pucciniastreae, 1936,
217 p. 202.

Caeoma caryophyllacearum Link, Willd., Sp. pl. VI, 2, 1825, p. 26.

Melampsorella elatina (Alb. et Schw.) Arth., N. Amer. Fl. VII, 1907, p. 111; 1925, p. 681; 1927, p. 814, 819; Moss, Ann. Botany, XL, 1926, p. 828—831, fig. 13, 14, 21, tab. XXXIV, fig. 3—5, 36—38, 42.

Aecidium elatinum Alb. et Schw., Consp. fung. Nisk., 1805, p. 121, tab. V, fig. 3.

Biol. Fischer, Ber. Deutsch. bot. Ges. XIX, 1901, S. 397; Ztschr. Pflanzenkr. XI, 1901 (1902), S. 321, Fig. 1—3; XII, 1902, S. 199, Taf. III, IV; Tubeuf, Ber. Deutsch. bot. Ges. XIX, 1901, S. 433; Arb. Biol. Abt. Land- u. Forstwirtsch. II, 2, 1901, S. 368; Centrbl. Bakteriol. II. Abt., IX, 1902, S. 241; Klebahn, Ztschr. Pflanzenkr. XII, 1902, S. 139; Jahrb. Hamburg. wiss. Anstalt. XX, 1902, S. 31; Bubák, Centrbl. Bakteriol. II. Abt., XII, 1904, S. 422; Arth., Mycologia, IV, 1912, p. 58; Vanin, Lesn. fitopatol., 1948, p. 118.

Spermagonia amphigenous, evident, in small convex patches, subcuticular, hemispherical, $99-317\mu$ across, $27-59\mu$ high, on an average $184 \times 36\mu$. Spermatia elongate, $3.9-4.9 \times 1.9-3.5\mu$ (according to Hunter).

Aecia on diffuse perennial mycelium infecting all young shoots and inducing formation of witches' broom, hypophyllous, deeply immersed, rounded or irregularly elongate, large, 0.5—1.0 mm across, depressed, utricular; peridium colorless, rupturing irregularly at the apex; peridial cells with thin outer and inner walls, verruculose. Aeciospores ellipsoid or subgloboid, $16-30 \times 14-18\mu$; walls thin, densely warted over entire surface; contents yellow.

Uredia amphigenous, mostly hypophyllous, usually scattered over the entire frond, small, 0.1—0.4 mm across, yellow, subepidermal, covered by hemispherical peridia consisting of polygonal cells, laterally elongate. Urediospores ellipsoid or ovoid, $16-30 \times 12-18\mu$; walls colorless, rather thin, rarely echinulate; contents yellow (Figure 42).

Telia produce pale or yellowish areas on the underside of leaves; these vary in extent and may cover the entire surface. Teliospores intra-
218 epidermal, their number fluctuating in each cell, unicellular, very rarely bicellular, $13-20\mu$ across; walls thin, smooth, colorless; contents colorless or pale yellowish.

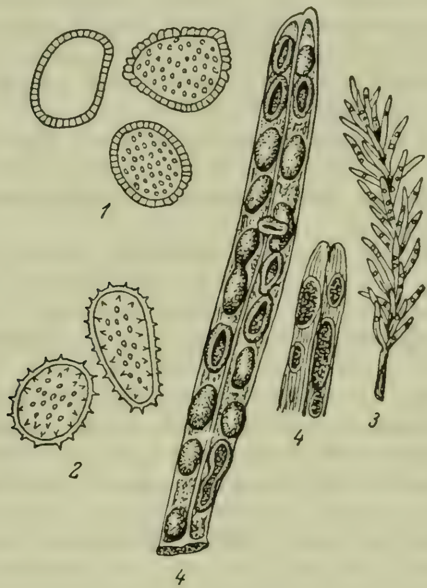


FIGURE 42. Melampsorella cerastii (Mart.) Winter:

1 — aeciospores on **Abies sibirica** Ledeb., × 600; 2—urediospores on **Stellaria graminea** L., × 600 (1, 2 — orig.); 3 — branch from witches' broom on **Picea alba** Link; 4 — needle of same spruce (after Engler).

Basidiospores subgloboid, $7-9\mu$, colorless or yellowish in mass.

Aecia on many fir species, on diffuse, perennial mycelium. Basidiospores infect young shoots which grow slightly thicker in fall; in the following spring the infected buds give rise to shoots on which the leaves (needles) are not disposed in two rows but spirally around the axis, and bear spermagonia and aecia. The infected leaves are shed in the fall, whereas the buds of infected shoots in the following year again produce diseased shoots which may continue for several years. The brooms are conspicuous in winter by the absence of needles on them. Uredio- and teliospores develop on species of **Stellaria, Malachium,** and **Cerastium;**

they were reported also on **Arenaria serpyllifolia** and **Moehringia trinervia**, as well as on the diffuse mycelium overwintering in the roots of other perennial host plants; the teliospores appear in the spring on the leaves of diseased shoots.

General distribution: Europe, Asia (in the USSR: Siberia and the Far East; Japan), North America.

In fir-free areas the fungus subsists by urediospores (on overwintering mycelium), through which it is propagated.

On **Abies sibirica** Ledeb. — EUROPEAN PART: V.-Kama (Kirov Region, Molotov Region, Sverdlovsk Region), Urals (Chelyabinsk Region: near Miass); W SIBERIA: Alt. (Altai Territory: Tigerek ravines, Kolyvanskoe village): E SIBERIA: Ang.-Say. (in the Khamar-Daban Range above Kultuk at Lake Baikal).

On **Abies alba** Mill. ? — EUROPEAN PART: U. Dns. ([former] Drogobych Region).

On **Abies nordmanniana** (Stev.) Spach — CAUCASUS: W Transc. (Georgia; upper Adzharia).

On **Abies sachalinensis** Mast. — FAR EAST: Sakh. (S Sakhalin, Kuril Is. (after Hiratsuka)).

On **Stellaria bungeana** Fenzl. — EUROPEAN PART: Urals (Sverdlovsk); W SIBERIA: Ob (Novosibirsk) Irt., Alt. (Altai); E SIBERIA: Yenis. (Turukhansk).

On **Stellaria radians** L. — FAR EAST: Sakh. (S Sakhalin).

On **Stellaria nemorum** L. — EUROPEAN PART: Kar.-Lap. (Karelian ASSR; Murmansk Region, Khibiny Mts.), Lad.-Ilm. (Leningrad Region; Kalinin Region: Kholm), U. V. (Ivanovo Region: Kineshma), U. Dns. (Drogobych Region).

On **Stellaria media** (L.) Cyr. — EUROPEAN PART: U. V. (Yaroslavl' Region: Rybinsk).

On **Stellaria diffusa** Willd. — FAR EAST: Sakh. (S Sakhalin).

On **Stellaria holostea** L. — EUROPEAN PART: Lad.-Ilm. (Leningrad Region), U. V. (Moscow Region), M. Dnp. and V.-Don (Kursk Region).

On **Stellaria palustris** Ehrh. (= S. glauca Wilh.) — EUROPEAN PART: Balt. (near Riga).

On **Stellaria graminea** L. — EUROPEAN PART: Kar.-Lap. (Karelian ASSR; Murmansk Region), Lad.-Ilm. (Karelian ASSR: Leningrad Region: Vyborg; Kalinin Region: Kholm), M. Dnp. (Kursk Region), V.-Don (near Kharkov (according to Treboux)).

On **Cerastium pauciflorum** Stev. (= **C. ledebourianum** Ser., **C. pilosum** Ledeb.) — EUROPEAN PART: Urals (Sverdlovsk Region: Mt. Blagodat).

219 On **Cerastium caespitosum** Gilib. (= **C. triviale** Link.) — EUROPEAN PART: Kar.-Lap. (Murmansk Region, Khibiny Mts.), Lad.-Ilm. (Leningrad Region: Luga), U. Dnp. (Minsk), U. Dns. (Lvov Region).

On **Cerastium vulgatum** L. var. **glandulosum** Rgl. — FAR EAST: Sakh. (Sakhalin, Kuril Is.).

The heteroecism of M. **cerastii** was detected by E. Fischer and confirmed by Tubeuf, Klebahn, and Bubák. In North America, in infection experiments with aeciospores from **Abies lasiocarpa** (Hook.) Nutt., Arthur (1912) obtained uredia on **Cerastium oreophilum** Greene. Hiratsuka (1936, p. 215) infected **Cerastium vulgatum** with aeciospores from **Abies mayriana** Miyabe et Kudo.

In Canada, in the northern United States, and in the mountains of western U.S.A. similar aecia occur on spruce, also causing the formation of witches' broom. The aeciospores proved infective for two species of Stellaria (Weir a. Hubert, Phytopathology, VIII, 1918, p. 114; see also: Rhoads, Hedgcock, Bethel a. Hartley, l.c., p. 331), the evolving uredia indistinguishable from those of **Melampsorella cerastii** obtained on the same species of **Stellaria** infected with aeciospores from spruce. Arthur (N. Amer. Fl., VII, 1925, pp. 647, 681) presents these aecia under the designation **Peridermium coloradense** Arth. et Kern.

The pathology of the fungus has not been studied. Many foresters have reported that spruce and other forest trees affected by witches' broom, even moderately, dry up within 10—15 years. However, these data cannot be verified ex post facto. It is possible that in the observed cases the death of the spruce and other forest trees was not directly correlated with the branch and trunk deformations. Control measures are limited to the removal of branches exposed to deformation.

On **Symphytum** (**Boraginaceae**).

2. **Melampsorella symphyti** (DC) Bubák, in Ber. Deutsch. bot. Ges. XXI, 1903, S. 356; Fischer, Ured. Schweiz, 1904, S. 523; Hariot, Uréd., 1908, p. 268; Bubák, Rostpilze Böhmens, 1908, S. 213; Migula, Kryptog.-Fl. Deutschl. III, 1, 1910, S. 489; Grove, Brit. Rust Fungi, 1913, p. 363, fig. 271; Klebahn, Kryptogfl. M. Brandb. Va, 1914, S. 825, Fig. Q2; Trotter, Fl. Ital. Crypt. Ured., 1914, p. 424; Syd., Monogr. Ured. III, 1915, p. 438, tab. XVIII, fig. 159; Hirats., Monogr. Pucciniastreae, 1936, p. 199; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 323, 325.

Syn.: **Uredo symphyti** DC, Encycl. bot. VIII, 1808, p. 232; Fl. franç. VI, 1815, p. 87; Sacc., Sylloge, VII, 1888, p. 87.

Coleosporium symphyti Fuckel, Symbol. mycol., 1869, p. 43.

Biol. Bubák, l.c., 1903, p. 356; Centrbl. Bakteriol. II. Abt., XII, 1904, S. 423; XVI, 1906, S. 155; Ann. mycol. II, 1904, p. 361.

Spermagonia mainly hypophyllous, rather thickly set, small, hemispherical or oblong, orange-yellow.

Aecia on local mycelium on the underside of needles (individual leaves) of current year, in 2 rows, rarely in proper sequence, short-cylindrical, 0.5—0.75 mm high, irregularly opening at the apex of the elongate cleft, at length torn into several lobes; peridial cells colorless, thin-walled,
220 with finely granular walls. Aeciospores mostly globoid, more rarely ovoid or elongate, 19.8—39.6 × 17.6—28.6 μ, orange-yellow; the spore walls under the ridgelike structure are densely verrucose over the entire surface, or smooth in places.

Uredia small, round, scattered rather densely over the entire, or almost the entire, surface of most fronds of the shoot, on the diffuse mycelium overwintering in the rootstock, covered by delicate peridia; peridial cells isodiametric, rupturing later. Urediospores ovoid or ellipsoid, 22—35 × 16—28 μ; walls colorless, 1.0—1.5 μ thick, echinulate, echinules 2 μ apart; contents, orange-yellow (Figure 43).

Teliospores develop in the spring, intracellularly in the epidermis so that the urediospores developing in the diffuse overwintered mycelium

occupy significant areas forming whitish or pale pink patches on the leaves, densely crowded in each cell, 11—18 × 9—15μ, pale yellowish, smooth.

Basidiospores globoid or ovoid, 7—9μ across.

Aecia were experimentally obtained on fir. Uredio- and teliospores on species of **Symphytum**.

General distribution: Almost throughout Europe.

On **Symphytum officinale** L. — EUROPEAN PART: Lad.-Ilm. (Leningrad Region: on Shelon River (former Novgorod Subregion)), V.-Kama (Molotov), M. Dnp. (Ukrainian SSR: Belaya Tserkov, Priluki), V.-Don. (Kharkov, Orel, Tambov), Transv. (Bashkir ASSR: Belebei); CAUCASUS: E Transc. (Georgia: Telavi).

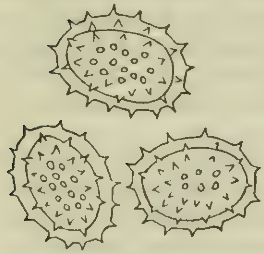


FIGURE 43. **Melampsorella symphyti** (DC) Bubák on **Symphytum officinale** L. Urediospores, × 600. (Orig.)

On **Symphytum asperum** Lepech. (= **S. asperrimum** Sims.) — CAUCASUS: W Transc. (Krasnodar Territory: Mzymta River).

On **Symphytum grandiflorum** DC (= **S. ibericum** Stev.) —CAUCASUS: W Transc. (Georgia: Sukhumi).

On **Symphytum tuberosum** L. — EUROPEAN PART: U. Dns. (Ternopol' Region).

On **Symphytum cordatum** W.K. — EUROPEAN PART: U. Dns. and M. Dnp. (Ternopol' Region, Stanislav Region).

Heteroecism of **M. symphyti** was detected by Bubák (l. c.). Sowing of basidiospores from Symphytum **tuberosum** on Abies alba Mill. (= **A. pectinata** DC) produced spermagonia within two weeks, and aecia after a month. Conversely, sowings of aeciospores from Abies and urediospores from Symphytum **tuberosum** on S. **tuberosum** and S. **officinale** were ineffective; the mycelium should, apparently, reach the rootstock after infection and then may infect the shoots in the following year, as it usually occurs in rusts with diffuse mycelia.

5. Genus PUCCINIASTRUM Otth

Otth, Mitt. Naturf. Ges. Bern, 1861, S. 71; Hirats., Beiträge zu einer Monographie der Gattung Pucciniastrum Otth, Journ. Faculty Agric. Hokkaido Univ. Sapporo, XXI, 3, 1927, p. 63—119, tab. 1.

Syn.: **Phragmopsora** Magn., Hedwigia, XIV, 1875, S. 123.

221 Spermagonia subcuticular, hemispherical, flat at the base.

Aecia with cylindrical peridium; peridial cells finely verrucose; contents of aeciospores orange-yellow.

Uredia subepidermal, protected by hemispherical or conical peridia, rupturing at the apical pore; paraphyses occur rarely if at all. Urediospores on short pedicels; walls echinulate, colorless; contents orange-yellow.

Teliospores subepidermal, intercellular, scattered, rarely crustose, dividing longitudinally or slightly anticlinically into 2, 4, or more cells.

Basidiospores globoid.

Teliospores develop at the end of summer and germinate in the following spring.

Thirty-three species are known; 30 species in Asia, of which 22 are specifically Asian, mainly East Asian; one species in the Hawaiian Islands; 6 species in Europe (and one imported from America?) of which 4 in common with Asia and America, one species only with Asia and one only with America. In North America 9 species are known, of which 2 species are found only in America, 4 species in common with Europe and Asia, 2 species only with Asia and one species only with Europe; one species is widespread in southern Africa and one in Australia.

As far as is known, aecia develop on the pine Abies, on Picea, or on Tsuga.

Key to Species of Pucciniastrum

I. On Corylus . . . . 1. P. coryli Kom.
II. On Rosaceae.
  A. Peridial cells around ostia smooth or faintly echinulate.
    1. On Agrimonia. . . . . 2. P. agrimoniae (Schw.) Tranz.
    2. On Potentilla . . . . 3. P. potentillae Kom.
  B. Peridial cells around ostia sharply echinulate. On Rubus.
    1. Uredia covered by hemispherical peridium. . . . . 4. P. arcticum (Lagerh.) Tranz.
    2. Uredia covered by coniform peridium . . . . 5. P. americanum Arth.
III. On Tilia . . . . 6. P. tiliae Miyabe.
IV. On Onagraceae
    1. On Circaeae . . . . 7. P. circaeae (Schum.) Speg.
    2. On Epilobium . . . . . . 8. P. pustulatum (Pers.) Diet.
V. On Pirolaceae. . . . 9. P. pirolae (Pers. apud Gmel.) Schroet.
VI. On Gentianaceae . . . . 10. P. ? beringianum Tranz.
VII. On Orchidaceae . . . . 11. P. ? goodyerae (Tranz.) Arth.
VIII. On Caprifoliaceae . . . . 12. P. miyabeanum Hirats.
IX. On Saxifragaceae . . . 13. P. hydrangeae-petiolaris Hirats.

On Corylus

1. Pucciniastrum coryli Kom. ex Jacz., Kom. et Tranz., Fungi Rossiae exs. No. 275, 1899 et in Hedwigia, XXXIX, 1900, S. 125; Sacc., Sylloge, XVI, 1902, p. 320; Syd., Monogr. Ured. III, 1915, p. 454, tab. XIX, fig. 161; Hirats., Monogr. Pucciniastrum, 1927, p. 97, tab. I, fig. 13; Monogr. Pucciniastreae, 1936, p. 240; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 159, 161.

222 Spermagonia and aecia unknown.

Uredia hypophyllous, scattered or in small groups, round, minute, 0.1 — 0.2 mm across, pale yellow covered by the epidermis and the hemispherical peridium; peridial cells irregularly polygonal, thin-walled, surrounding the pore, rounded or ellipsoid, smooth. Urediospores globoid, ovoid, or ellipsoid, $18-27 \times 10-16\mu$, with colorless, echinulate walls and yellow contents (Figure 44).

Telia hypophyllous, minute, yellow. Teliospores subepidermal, intercellular, scattered or gregarious, round, ellipsoid, or, owing to reciprocal pressure, prismatic, dividing into 2—8 cells, 18—30 × 12—15μ, with brownish, smooth walls.

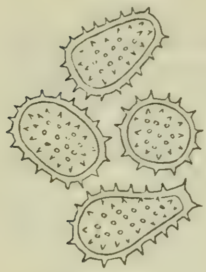


FIGURE 44. Pucciniastrum coryli Kom. on Corylus heterophylla Fisch. et Trautv. Urediospores, × 600. (Orig.)

General distribution: On species of **Corylus** in the Soviet Far East, in Manchuria, and in Japan.

On **Corylus heterophylla** Fisch. et Trautv. — FAR EAST: Uss. (Maritime Territory near Okeanskaya station (Amur Bay)).

On **Corylus mandshurica** Maxim. (= **C. sieboldiana** Bl. var. **mandshurica** Schneid., **C. rostrata** var. **mandshurica** Rgl.) — FAR EAST: Uss. (Maritime Territory; in the Maikhe River basin in the Shkotovo District).

Reported from the shores of the Black Sea, mostly admixed with **Melampsoridium carpini**, the uredia of which are distinguished by the cells of the peridial opening extruded into a spinule.

The pathogenicity of the fungus is scarcely known. In the teliospore stage the fungus causes premature death and extensive damage to the foliage causing weakening of severely infected trees.

On Rosaceae

2. **Pucciniastrum agrimoniae** (Schw.) Tranzschel, Bot. zap., izdav. Bot. sad. SPb. univ. IV, 1895, p. 301; Fischer, Ured. Schweiz, 1904, S. 465; Arth., N. Amer. Fl. VII, 1907, p. 106; 1925, p. 676; 1927, p. 818; Hariot, Uréd., 1908, p. 251; Sacc., Sylloge, XXI, 1912, p. 733; Grove, Brit. Rust Fungi, 1913, p. 364, fig. 272; Klebahn, Kryptogfl. M. Brandb. Va, 1914, p. 834, fig. R4; Syd., Monogr. Ured. III, 1915, p. 446; Ludwig a. Rees, Amer. Journ. Bot. V, 1918, p. 55, tab. VIII, fig. 1—4; Dodge, Journ. Agric. Res. XXIV, 1923, p. 890, 891, tab. 5, fig. D—g; Fragoso, Fl. Iber. Ured. II, 1925, p. 261, fig. 129; Dodge, Bothalia (Pretoria), II, 1926, p. 161; Hirats., Monogr. Pucciniastrum, 1927, p. 86; Arth., Manual Rusts U. S. a. Canada, 1934, p. 14, fig. 23; Hirats., Monogr. Pucciniastreae, 1936, p. 231; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 222, 226.

Syn.: **Caeoma** (Uredo) **agrimoniae** Schw., Trans. Amer. Phil. Soc. II, 4, 1832, p. 291.

Uredo potentillarum ζ **agrimoniae-eupatoriae** DC, Fl. franc. VI, 1815, p. 81.

Coleosporium ochraceum Bon., Coniom. u. Crypt., 1860, S. 20.

223 **Thekopsora agrimoniae** Diet., Hedwigia, XXIX, 1890, S. 153.

Pucciniastrum agrimoniae-eupatoriae (DC) Lagerh., Tromso Mus. Aarsh. XVII, 1895, p. 92; Liro, Ured. Fenn., 1908, p. 508.

Pucciniastrum agrimoniae (DC) Lagerh. ex Bubák, Rostpilze Böhmens, 1908, S. 186; Migula, Kryptog.-Fl. Deutschl. III, 1, 1910, S. 468; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 222, 226.

Pucciniastrum agrimoniae-eupatoriae (DC) Tranz. ex Trotter, Fl. Ital. Crypt. Ured., 1914, p. 382.

Biol. Klebahn, Ztschr. Pflanzenkr. XVII, 1907, S.149; Fraser, Mycologia, IV, 1912, p.191.

Spermagonia and aecia unknown.

Uredia hypophyllous, scattered or in groups, frequently very abundant, round, small, 0.4 mm across, yellow, covered by the epidermis and the hemispherical peridia; peridial cells minute, thin-walled, smooth, except for the cells surrounding the apical pore of the peridium, which are large, thick-walled, smooth or sparsely echinulate. Urediospores globoid or ellipsoid, $15-22 \times 14-19\mu$, with colorless echinulate walls and yellow contents.

Telia hypophyllous, yellow, later turning brown. Teliospores intercellular, subepidermal, scattered or gregarious and forming sizable crusts; round or prismatic, $18-30 \times 16-30\mu$, divided by longitudinal anticlinal septa, usually into 4 cells (Figure 45).

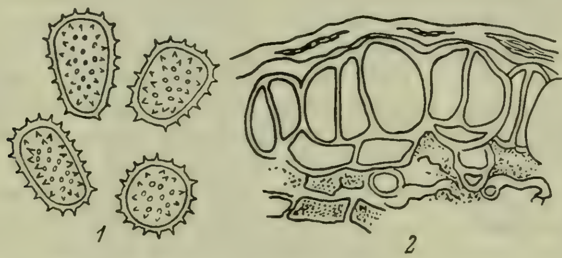


FIGURE 45. **Pucciniastrum agrimoniae** (Schw.) Tranz.:

1 — urediospores on **Agrimonia pilosa** Ledeb., × 600. (Orig.);
2 — teliospores on **A. eupatoria** L. (After Klebahn)

On species of **Agrimonia**.

General distribution: Europe, Asia (as far as India and Japan) North and South America, southern Africa.

On **Agrimonia eupatoria** L. — EUROPEAN PART: Lad.-Ilm. (Leningrad Region: Luga), U. V. (Moscow Region), Balt. (Latvian SSR, Lithuanian SSR), U. Dnp. (Kiev, Oster), M. Dnp. (Kursk Region; Ternopol' Region), V.-Don (Voronezh Region; Kharkov), U. Dns. (Lvov Region), L. Don (Stalino [Donetsk] Region): CAUCASUS: Cisc. (Ordzhonikidze [Stavropol] Territory: Voroshilovsk [Stavropol]), W Transc. (Georgian SSR: Batumi), E Transc. (Azerbaijan: Kusary), S Transc. (Georgian SSR: Borzhomi); CENTRAL ASIA: S. Dar. (Uzbek SSR: Tashkent).

On **Agrimonia pilosa** Ledeb. s. l. — EUROPEAN PART: Balt. (Lithuanian SSR), U. Dns. (Smolensk), U. V. (Moscow, Kaluga), V.-Kama (Molotov, Krasnoufimsk, Tatar ASSR), U. Dnp. (Kiev), V.-Don (Tambov, Syzran), L. Don (Balashov); CAUCASUS: Cisc. (Ordzhonikidze); W SIBERIA: Ob
224 (Tobol'sk, Tara, Eniseisk), U.-Tob. (Chelyabinsk Region: Sharinsk), Irt. (Omsk) Alt. (Sayans, Nizhneudinsk); E SIBERIA: Dau. (Buryat-Mongol ASSR: Kyakhta); FAR EAST: Ze.-Bu. (Amur Region), Uss. (Khabarovsk, Maritime Territory), Sakh. (S Sakhalin, Kuril Is.).

On **Agrimonia odorata** Mill. — EUROPEAN PART: U. Dnp. (Stanislav Region).

Teliospores develop as a rule in Asia, and only seldom in Europe. Klebahn proved that the fungus is maintained by overwintering urediospores;

sowings of teliospores on Abies alba, Picea excelsa and Larix decidua were ineffective because of unsuitable material. Fraser reported abundant development of telio- and urediospores in the northeastern part of North America, but failed to germinate teliospores; the fungus overwinters in the urediospore stage.

3. **Pucciniastrum potentillae** Kom. ex Tranz., Jacz., Kom., Fungi Rossiae exs. No. 327, 1899 et in Hedwigia, XXXIX, 1900, S. (127); Sacc., Sylloge, XVI, 1902, p. 319; Syd., Monogr. Ured. III, 1915, p. 449; Arth., N. Amer. Fl. VII, 1925, p. 676; Hirats., Monogr. Pucciniastrum, 1927, p. 91, tab. I, fig. 10; Arth., Manual Rusts U. S. a. Canada, 1934, p. 14, fig. 22; Hirats., Monogr. Pucciniastreae, 1936, p. 237; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 227.

Spermagonia and aecia unknown.

Uredia hypophyllous, scattered or in groups, frequently covering extensive areas of the leaves, round, minute, 0.1 — 0.2 mm across, yellow, covered by hemispherical peridium; peridial cells small, thin-walled, smooth; cells at the peridial pore large, thick-walled, sparsely echinulate or smooth. Urediospores broad-ovoid, ellipsoid or globoid, $14-20 \times 12-18\mu$; walls colorless, thin and rarely echinulate; contents yellow (Figure 46).

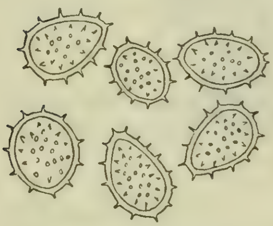


FIGURE 46. **Pucciniastrum potentillae** Kom. on **Potentilla fragarioides** L. Urediospores, × 600. (Orig.)

Telia hypophyllous, subepidermal, producing small reddish-brown patches. Teliospores intercellular, globoid or ellipsoid, 2- to 4-celled, $14-26 \times 15-20\mu$; walls brown; develop in September-October.

On species of **Potentilla**. In Japan on **P. centigrana** Max. and **P. cryptotaeniae** Maxim., in eastern Canada and the northeastern U. S. A. on **P. tridentata** Sol. (= **Sibbaldiopsis tridentata** Rydb.).

General distribution: eastern Asia, northeastern North America.

On **Potentilla fragarioides** L. — W SIBERIA: Alt. (Oirot [Gorno-Altai] Autonomous Region: Chemal village); FAR EAST: Uss. (Maritime Territory, frequent), Kamch., Sakh. (S Sakhalin).

On **Potentilla freyniana** Bornm. — FAR EAST: Uss. (Maritime Territory: Vladivostok, Strelok Strait, Vostok Gulf, Lozovyi: Klyuch in the Suchan District, Novokievskoe village in the former Pos'et District).

4. **Pucciniastrum arcticum** (Lagerh.) Tranz., Bot. zap. izdav.
225 Bot. sad. SPb. univ. IV, 1895, p. 300; Arth., N. Amer. Fl. VII, 1907, p. 107; 1925, p. 677; Liro, Ured. Fenn., 1908, p. 507, 582; Sacc., Sylloge, XXI, 1912, p. 733; Syd., Monogr. Ured. III, 1915, p. 449; Fragoso, Fl. Iber. Ured. II, 1925, p. 262; Moss, Ann. Botany, XL, 1926, p. 834, text fig. 18, 21 H, tab. XXXIV, fig. 8, 13; Hirats., Monogr. Pucciniastrum, 1927, p. 90; Arth., Manual Rusts U. S. a. Canada, 1934, p. 13, fig. 21; Hirats., Monogr. Pucciniastreae, 1936, p. 228; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 218, 227.

Syn.: **Uredo arcticus** Lagerh., Hedwigia, XXXVIII, 1889, S. 109; Sacc., Sylloge, IX, 1891, p. 331.

Aecidium ingenuum Arth., Bull. Torrey Bot. Club, XI, 1919, p.124.

Peridermium ingenuum Arth. ex Rhoads, Hedgcock, Bethel a. Hartley, Phytopathology, VIII, 1918(!), p.336 (sine diagnosi); Syd., Monogr. Ured. IV, 1923, p.3; Arth., N. Amer. Fl. VII, 1924; p.646; Sacc., Sylloge, XXIII, 1924, p.3.

Biol. Darker, Journ. Arn. Arb. X, 1929, p.156; Hunter, Journ. Arn. Arb. XVII, 1936, p.122, fig.12 (spermagonium).

Spermagonia hypophyllous, discoid, inconspicuous, subcuticular, 80 — 130μ across, 40 — 50μ high. Spermatia 3.9 — 4.7 × 1.3 — 1.6μ.

Aecia hypophyllous, at times amphigenous, thickly set, frequently confluent; peridia almost cylindrical or ligulate, 0.5 — 0.8 mm high, very delicate and brittle; peridial cells narrow-elongate or linear in radial section, 32 — 47 × 14 — 21μ, somewhat overlapping, outer walls 1 — 2μ thick, smooth, inner walls 3 — 5μ thick, densely verruculose. Aeciospores globoid or broad-ellipsoid, 17 — 25 × 14 — 18μ; walls colorless, 2 — 3μ thick, half the thickness consisting of thickly set, rather thin, partly deciduous rods.

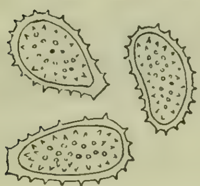


FIGURE 47. **Pucciniastrum arcticum** (Lagerh.) Tranz. on **Rubus arcticus** L. Urediospores, × 600. (Orig.)

Uredia hypophyllous, scattered or in groups, occasionally covering extensive parts of the leaves, round, small, 0.1 — 0.2 mm across, yellow, covered by hemispherical peridia; peridial cells small, somewhat elongate, thin-walled, smooth; lower wall of cells adjoining peridial ostiole thicker; ostiolar cells of peridia thick-walled, coarsely echinulate. Urediospores ovoid or oblong-ovoid, 17 — 27 × 12 — 16μ; walls colorless, echinulate, with yellow contents; pore barely perceptible (Figure 47).

Telia hypophyllous. Teliospores in small groups intercellular, subepidermal, globoid or angular, 2- to 4-celled, 19 — 25μ across; walls brownish, smooth. Teliospores develop late, and are rarely detected.

On species of **Rubus**.

General distribution: Europe, Asia, North America.

On **Rubus arcticus** L. — EUROPEAN PART: Kar.-Lap. (Karelian ASSR; Murmansk Region: Kola), V.-Kama (Kirov Region: Kotel'nich; Molotov Region: Dobryanskii Zavod, Krasnoufimsk): W SIBERIA: Ob (Tobol'sk, Tara, Eniseisk); E SIBERIA: Yenis. (Krasnoyarsk Territory: Turukhansk),
226 Lena-Kol. (Yakut ASSR: former Vilyuisk Subregion), Ang.-Say. (Irkutsk Region: Balagansk); FAR EAST: Kamch., Sakh. (S Sakhalin).

On **Rubus saxatilis** L. — EUROPEAN PART: Kar. Lap. (Karelian ASSR), Lad.-Ilm. (Leningrad Region: Luga District), U. Dnp. (Gomel').

Darker successfully infected (l. c.) **Picea canadensis** (Mill.) B. S. P., (= **P. alba** Link) with teliospores from **Rubus triflorus**, in Canada; failed to infect **Picea mariana** (Mill.) B. S. P., **Abies balsamea** Mill. and **Tsuga canadensis** Carr. **Rubus triflorus** proved susceptible to infection with aeciospores from **Picea**, whereas **R. strigosus** proved resistant to the same.

5. **Pucciniastrum americanum** Arth., Bull. Torrey Bot. Club, XLVII, 1920, p.468; Dodge, Journ. Agric. Res. XXIV, 1923, p.885, tab.1 — 4, 5 (A, B, C); Arth., N. Amer. Fl. VII, 1925, p.677; Moss, Ann. Botany, XL, 1926, p.832 — 834, fig.15 — 17, tab. XXXIV, fig.7, 11, 12;

Hirats., Monogr. Pucciniastrum, 1927, p. 89; Arth., Manual Rusts U. S. a. Canada, 1934, p. 13, fig. 20; Hirats., Monogr. Pucciniastreae, 1936, p. 225; Hunter, Journ. Arn. Arb. XVII, 1936, p. 121.

Syn.: **Pucciniastrum arcticum** var. **americanum** Farlow., Rhodora, X, 1908, p. 16; Syd., Monogr. Ured. III, 1915, p. 450.

Accidium ingenuum Arth. see **Pucciniastrum arcticum** (Lagerh.) Tranz.

Peridermium ingenuum Arth. see **Pucciniastrum arcticum** (Lagerh.) Tranz.

Biol. Darker, Journ. Arn. Arb. X, 1929, p. 156.

Spermagonia and aecia indistinguishable from those of **Pucciniastrum arcticum** (Lagerh.) Tranz. According to Darker (l. c.) spermatia 3.9 — 5.9 × 2.0 — 2.4 μ, and aeciospores, 20 — 28 × 17 — 21 μ.

Uredia hypophyllous, scattered or in groups over extensive areas of the leaves, round, small. yellow. covered by conical peridia developing above the epidermis; peridial cells thin-walled, flat, elongate; ostiolar cells of peridia almost globoid, constricted below the middle; outer walls thin, smooth, inner walls greatly thickened, coarsely echinulate. Urediospores ovoid or elongate-ovoid, 15 — 28 × 10 — 18 μ; walls colorless, thin, sparsely echinulate; contents yellow.

Telia small, hypophyllous, subepidermal. Teliospores ellipsoid, 24 — 28 μ across, with brownish smooth walls.

On raspberries (**R. melanolasius** Focke, **R. strigosus** Michx., and **R. neglectus** Peck) in Canada and the U. S. A., in the west from British Columbia to Idaho, in the east from Quebec to West Virginia. In the USSR (Asia) not known. The fungus might occur in the Soviet Far East.

It was experimentally demonstrated by Darker (l. c.) that **Pucciniastrum americanum** infects **Picea canadensis** (Mill.) B. S. P. (= **P. alba** Link); the fungus is not borne on **Picea mariana** (Mill.) B. S. P. (= **P. nigra** Ait.), **Abies balsamea** Mill., and Tsuga **canadensis** Carr. Reverse sowing infected **R. strigosus** but failed to infect **R. triflorus** and **Agrimonia mollis**.

On Tilia

6. **Pucciniastrum tiliae** Miyabe ex Hirats., Bot. Mag. Tokyo, XI, 1897, p. 47, tab. IV, fig. 12 — 20; Rev. Mycol. XXI, 1899, p. 37; Sacc., Sylloge, XIV, 1902, p. 363; Syd., Monogr. Ured. III, 1915, p. 453; Hirats., Monogr. Pucciniastrum, 1927, p. 83; Monogr. Pucciniastreae, 1936, p. 248;
227 Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 275.

Biol. Kamei, Trans. Sapporo Nat. Hist. Soc. XII, 1932, p. 165; Hirats., l. c., 1936.

Spermagonia abundant, in groups, subcuticular, lenticular, 130 — 210 μ across, 20 — 70 μ high. Spermatia elongate, 4.0 — 8.5 × 1.5 — 2.5 μ.

Aecia hypophyllous, deeply immersed, cylindrical, up to 3.5 μ high, about 2.0 μ across; peridia colorless, opening at the apex; peridial cells ovoid to ellipsoid, 48 — 74 × 15 — 22 μ, slightly overlapping; inner walls thin, finely verrucose; outer walls thin, smooth. Aeciospores globoid or ellipsoid, 19 — 33.5 × 12 — 22 μ; walls thin, finely verrucose, except for a small, almost smooth area; contents orange-yellow.

Uredia hypophyllous, scattered or in groups, small, up to 0.2 mm across, covered by peridia; ostiolar cells of peridium smooth. Urediospores

globoid, ovoid or ellipsoid, 19 — 26 × 12 — 15 μ; walls echinulate, contents yellow (Figure 48).

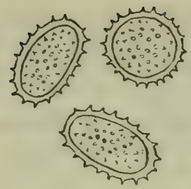


FIGURE 48. Pucciniastrum tiliae Miyabe on Tilia mandshurica Rupr. et Maxim. Urediospores, × 600. (Orig.)

Telia hypophyllous, brown, forming somewhat shiny crusts, bordered by fibers. Teliospores intercellular, 2- to 6-celled, round or angular, 20 — 36 × 15 — 30 μ, with light brown smooth walls.

Aecia on **Abies**.

General distribution: eastern Asia (USSR: Far East; China; Japan).

On **Tilia mandshurica** Rupr. et Maxim. — FAR EAST: Uss. (Maritime Territory, Ussuri floristic region (frequent)).

On **Tilia amurensis** Kom. — FAR EAST: Uss. (Maritime Territory: in mountains in the Maikhe River basin (rarely, the fungus develops weakly)).

Kamei established the linkage of the fungus with **Abies mayriana** Miyabe by experimental infections with sporidial teliospores from Tilia maximo-**wicziana** Shisawa. Nothing is known about the pathogenicity of the fungus.

On Onagraceae

7. **Pucciniastrum circaeae** (Schum.) Speg., Decad. Myc. Ital. No. 65, 1879; Sacc., Sylloge, VII, 1888, p. 763; Fischer, Ured. Schweiz, 1904, S. 461, Fig. 302; Hariot, Uréd., 1908, p. 250; Bubák, Rostpilze Böhmens, 1908, S. 186; Liro, Ured. Fenn., 1908, p. 511; Migula, Kryptog.-Fl. Deutschl. III, 1, 1910, S. 468, Taf. XC, Fig. 1, 2; Grove, Brit. Rust Fungi, 1913, p. 365, fig. 273; Trotter, Fl. Ital. Crypt. Ured., 1914, p. 382, fig. 31; Klebahn, Kryptogfl. M. Brandb. Va, 1914, S. 833, Fig. R3; Syd., Monogr. Ured. III, 1915, p. 445, tab. XIX, fig. 160; Fragoso, Fl. Iber. Ured. II, 1925, p. 259, fig. 128; Hirats., Monogr. Pucciniastreae, 1936, p. 251; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 285.

Syn.: **Uredo circaeae** Schum., Enum. plant. Saeland. II, 1803, p. 228.

Melampsora circaeae Thüm. Mycoth. univers. No. 447, 1876; Winter,
228 Pilze Deutschl. I, 1881, S. 243.

Biol. Bubák, Centrbl. Bakteriol., II Abt., XVI, 1906, S. 158; Klebahn, Ztschr. Pflanzenkr. XVII, 1907, p. 150; Fischer, Centrbl. Bakteriol., II Abt., XLVI, 1916, S. 334; Mitt. Naturf. Ges. Bern, 1916, S. 134, Fig. 2.

Spermagonia subcuticular, small, flat, 100 — 130 μ across, 25 — 35 μ high, honey-colored.

Aecia mostly hypophyllous, rarely amphigenous, cylindrical, up to 1 mm high, 0.5 mm in diameter, tearing irregularly; peridial cells extremely flattened, outer walls thin, smooth, inner walls thicker, punticulate. Aeciospores yellow, from globoid to elongate, 14 — 32 × 11 — 21 μ, with colorless walls thickly set with minute verrucules with smooth sectors frequently disposed in longitudinal stripes.

Uredia hypophyllous, scattered, round, small, 0.1 — 0.25 mm across, pale yellow, covered by hemispherical peridia; peridial cells thin-walled, smooth, except around the peridial pore where cells have somewhat thicker, smooth walls. Urediospores globoid, ellipsoid, ovoid or oblong, 14 — 24 × 12 — 16 μ, with colorless, echinulate walls and yellow contents (Figure 49).

Telia subepidermal, intercellular, in small groups, globoid or ellipsoid, 2- to 4-celled, 18—30μ across, 16—20μ high, with smooth yellowish walls, up to 2μ thick. Basidiospores globoid, 7—9μ in diameter, with pale reddish contents.

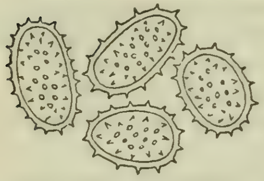


FIGURE 49. Pucciniastrum circaeae (Schum.) Speg. on Circaea alpina L. Urediospores, × 600. (Orig.)

Uredio- and teliospores on species of **Circaea.**

General distribution: Europe, Asia (as far as Japan).

On **Circaea alpina** L. — EUROPEAN PART: Lad.-Ilm. (Leningrad Region), Balt. (Estonian SSR, Latvian SSR, Lithuanian SSR), U. V.; E SIBERIA: Lena-Kol. (Irkutsk Region: Kirensk); FAR EAST: Sakh. (Sakhalin, Kuril Is.).

On **Circaea lutetiana** L. — EUROPEAN PART: Balt. (Latvian SSR, Lithuanian SSR), U. Dnp. (Belorussian SSR), M. Dnp. (Ternopol' Region); CAUCASUS: W Transc. (Abkhaz ASSR).

After unsuccessful experimental infections carried out by Bubák (1906) and Klebahn (1907), aecia were obtained by Fischer (1916) on **Abies alba** (= **A. pectinata**) following infection of very young shoots with overwintered teliospores.

8. **Pucciniastrum pustulatum** (Pers.) Diet. in Engler u. Prantl, Natürl. Pflanzenfam. I, 1, 1897, S. 47, Fig. 29 (D); Arth., N. Amer. Fl. VII, 1907, p. 107; 1925, p. 677; 1927, p. 814, 818; Grove, Brit. Rust Fungi, 1913, p. 336, fig. 274; Bell, Bot. Gaz. LXXVII, 1924, p. 17, 24, tab. IV, fig. 31, 32; tab. V, fig. 40, 41; Moss, Ann. Botany, XL, 1926, p. 842, fig. 21 (3), tab. XXXIV, fig. 17; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 159, 161.

Syn.: **Pucciniastrum epilobii** Otth, Mitt. Naturf. Ges. Bern, 1861, S. 72; Sacc., Sylloge, VII, 1888, p. 762; Fischer, Ured. Schweiz, 1904, S. 459; Hariot, Uréd., 1908, p. 251; Liro, Ured. Fenn., 1908, p. 509; Bubák, Rostpilze Böhmens, 1908, S. 185; Migula, Kryptog.-Fl. Deutschl. III, 1, 1910, S. 468; Klebahn, Kryptogfl. M. Brandb. Va, 1914, S. 831, Fig. R2;
229 Trotter, Fl. Ital. Crypt. Ured., 1914, p. 381; Fragoso, Fl. Iber. Ured. II, 1925, p. 258; Hunter, Bot. Gaz. LXXXIII, 1927, p. 8, tab. II, fig. 6; Journ. Arn. Arb. XVII, 1936, p. 121; Hirats., Monogr. Pucciniastreae, 1936, p. 255.

Phragmopsora epilobii Magn., Hedwigia, XIV, 1875, S. 123.

Uredo pustulata Pers. α epilobii Pers., Synops. fung., 1801, p. 219.

Pucciniastrum abieti-chamaenerii Kleb., Jahrb. wiss. Bot. XXXIV, 1900, S. 387; Kryptogfl. M. Brandb. Va, 1914, S. 829, Fig. R1; Syd., Monogr. Ured. III, 1915, p. 442; Fragoso, Fl. Iber. Ured. II, 1925, p. 257, fig. 127; Hunter, Journ. Arn. Arb. XVI, 1936, p. 121.

Pucciniastrum pustulatum (Pers.) Diet. subsp. **P. abieti-chamaenerii** Kleb., Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 284, 285.

Pucciniastrum chamaenerii Rostr., Plantepatologi, 1902, p. 302; Bubák, Rostpilze Böhmens, 1908, S. 184, Fig. 44; Migula, Kryptog.-Fl. Deutschl. III, 1, 1910, S. 467, Taf. XC, Fig. 5—7.

Biol. Klebahn, Ztschr. Pflanzenkr. VIII, 1898; IX, 1899, S. 23; XV, 1905, S. 94; Jahrb. wiss. Bot. XXXIV, 1900; XXXV, 1901; Fischer, Ber. Schweiz. bot. Ges. X, 1900; Tubeuf, Centrbl. Bakteriol. II Abt., IX, 1902, S. 241; Bubák, Centrbl. Bakteriol. II Abt., XVI, 1906, S. 150; Fraser,

Mycologia, IV, 1912, p.175; Weir a. Hubert, Phytopathology, VI, 1916; VII, 1917; Rhoads, Hedgcock, Bethel a. Hartley, Phytopathology, VIII, 1918, p.329; Faull, Journ. Arn. Arb. XIX, 1938, p.163—175; Hirats., Monogr. Pucciniastreae, 1936, p.265.

Spermagonia hypophyllous, hemispherical, rising above the leaf surface, minute, subcuticular, 62—137 μ wide, 15—33 μ high. Spermatia prismatic, 3.3 × 1.6 μ (according to Hunter).

Aecia hypophyllous, cylindrical, 1 mm high, 0.3 mm in diameter, opening irregularly; peridial cells stretched out, thin-walled, outer walls smooth, inner walls minutely verrucose. Aeciospores mostly ellipsoid or ovoid, 1.0—1.5 μ thick, verruculose, with a smooth oblong band; contents yellow.

Uredia hypophyllous, scattered or in small groups, 0.1—0.25 mm across, yellow, covered by hemispherical peridia under raised epidermis; peridial cells thin-walled, smooth; periostial cells distinguished by slightly thicker walls. Urediospores ellipsoid or ovoid, 13—23 × 10—16 μ; walls colorless, thin, sparsely and thinly echinulate; contents orange-yellow (Figure 50).

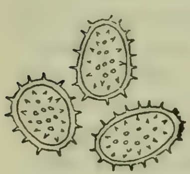


FIGURE 50. Pucciniastrum pustulatum (Pers.) Diet. on Epilo-
230 bium montanum L. Urediospores, × 600. (Orig.)

Telia mostly hypophyllous, rarely amphigenous, small, when spores develop profusely — confluent, black-brown. Teliospores subepidermal and intercellular in the parenchyme, round; following mutual pressure frequently prismatic, 2- to 4-celled, 17—35 × 7—30 μ; walls smooth, thin, 1 μ, thicker above, up to 3 μ, with pore.

Aecia on species of **Abies**. Uredio- and teliospores on species of **Chamaenerium** and **Epilobium**.

General distribution: Europe, Asia, North America, New Zealand.

On **Epilobium hirsutum** L. — EUROPEAN PART: M. Dnp. (Kursk), V.-Don (Syzran); CAUCASUS: E Transc. (Georgian SSR: Tbilisi).

On **Epilobium montanum** L. — EUROPEAN PART: Lad.-Ilm. (Leningrad Region), Balt. (Latvian SSR), U. V. (Moscow Region, Ivanovo Region), V.-Kama (Kirov Region) V.-Don (Tambov (Botanical Garden); Voronezh Region).

On **Epilobium roseum** (Schreb.) Pers. — EUROPEAN PART: Lad.-Ilm. (Leningrad Region), Balt. (Estonian SSR), U.V. (Kalinin Region), V.-Kama (Molotov), M. Dnp. (Ternopol' Region, Vinnitsa Region) V.-Don (Chuvash ASSR): Yadrin), V.-Don (Saratov, Tambov (Botanical Garden)).

On **Epilobium palustre** L. — EUROPEAN PART: Kar.-Lap. (Karelian ASSR; Murmansk Region), Dv.-Pech. (Arkhangel'sk Region: Kargopol'), Lad.-Ilm. (Leningrad Region, Kalinin Region), U. V. (Moscow Region), L. Don (Saratov); W SIBERIA: Ob (Tobol'sk) Yenis. (Eniseisk), Lena-Kol. (Irkutsk Region: Kirensk); E SIBERIA: Dau. (Buryat-Mongol ASSR: Kyakhta).

Forma specialis — **Pucciniastrum abieti-chamaenerii** Kleb.:

On **Abies sibirica** Ledeb. — EUROPEAN PART: Lad.-Ilm. (Leningrad Region: in a park in Levashov near Leningrad).

On **Chamaenerium angustifolium** (L.) — EUROPEAN PART: Kar.-Lap. (Karelian ASSR). Dv.-Pech. (Vologda Region: Kadnikov; Komi ASSR; Pechora), Lad.-Ilm. (Leningrad Region), Balt. (Latvian SSR), U. V. (Smolensk, Moscow and Ivanovo regions'), V.-Kama (Kirov Region, Molotov Region, Tatar ASSR), V. Dnp. (Smolensk and Orel regions),

M. Dnp. (Ternopol' Region), V.-Don (Voronezh Region), Urals (Sverdlovsk Region); CAUCASUS: W Transc. (former Batumi Region (Voronov)); W SIBERIA: Ob (Tobol'sk, Tomsk, Tara, Krasnoyarsk), Irt. and Alt. (Altai); E SIBERIA: Lena-Kol. (Irkutsk Region: Kirensk Region), Ang.-Say. (Irkutsk Region: Murino, Balagansk; Buryat-Mongol. ASSR: Tankhoi, Kyakhta); FAR EAST: Uss. (Maritime Territory: Shkotovo District), Sakh. (Sakhalin I.).

On **Chamaenerium angustissimum** (Weber) Grossheim (= **Epilobium palustre** L., **Epilobium dodonaei** Vill.) — CAUCASUS: W Transc. (Abkhazian ASSR (Siemaszko)), E Transc. (Georgian SSR: Maturis-Khebi in Pshavli).

On **Chamaenerium caucasicum** (Hausskn.) D. Sosn. — CAUCASUS: E Transc. (Georgian SSR: Arkhoty (Arakhvety?) in Khevsuriya).

On **Chamaenerium latifolium** (L.) Th. Fr. et Lange — EUROPEAN PART: Dv.—Pech. (Shchugor River).

Some authors, among them Klebahn and Lydow) distinguish two species: **Pucciniastrum pustulatum** (Pers.) Diet. pr. p. sensu stricto (= **P. epilobii** Otth) and **P. abieti-chamaenerii** Kleb. (= **P. chamaenerii** Rostr.); other authors, such as Arthur and Hiratsuka, recognize only one species. The morphological differences between these species are quite insignificant. Faull (1938) demonstrated the following distinctive features: aecia of **P. abieti-chamaenerii** are narrower, 0.012 — 0.025 mm across, peridial brittle, walls of peridial cells up to 1 μ thick, aeciospores, on an average, about 19 × 15 μ and very sparsely verrucose, urediospores broader, 19 × 16 μ. Conversely, aecia of **P. pustulatum** are somewhat wider, 0.02 — 0.04 mm
231 across, peridia larger, walls of peridial cells up to 2.5 μ thick, aeciospores, on an average, 18 × 14 μ and rather coarsely warted, urediospores narrower, 19 × 14 μ; teliospores are indistinguishable in structure, size and shape. We consider these fungi as special forms. Biologically they are distinguished by the hosts: **P. pustulatum** s. str. occur on species of section **Lysimachion**, genus **Epilobium**, whereas **P. abieti-chamaenerii**, on species of genus **Chamaenerium** (considered by some authors as a section of genus **Epilobium**).

Klebahn (l. c.) obtained aecia and spermagonia of the special form **P. abieti-chamaenerii** by sowing teliospores from **Chamaenerium angustifolium** on **Abies alba** and back-infecting **Chamaenerium** with the developed aeciospores, but failed to infect with the aeciospores and urediospores of this fungus several species of **Epilobium** from the section **Lysimachion**. There results were verified and confirmed in subsequent experimental infections of **Chamaenerium angustifolium**, by Fischer (l. c.) in Switzerland, Tubeuf (l. c.) in Germany, Bubák (l. c.) in Bohemia. In North America the connection of the fungus on **Chamaenerium** with the aecia on **Abies balsamea** was proved by Fraser (l. c.) and on **A. lasiocarpa** by Weir and Hubert (l. c.). In Japan, Hiratsuka (l. c., p. 265) infected **Abies mayriana** with teliospores from **Chamaenerium**.

Dietel and others (Rhoads et al., 1918) have proved the heteroecism of the special form, which develops uredio- and teliospores on species of **Epilobium** (section **Lysimachion**) by the uredia obtained on **Epilobium adenocaulon** after infection with aeciospores from **Abies concolor**. Faull (l. c.) has repeatedly infected **Abies balsamea** with teliospores from **Epilobium adenocaulon**, and vice versa — **E. adenocaulon** with aeciospores from **A. balsamea**, while **Chamaenerium angustifolium** was not infected by

the latter. Performing the same experiments with the fungus on Chamaenerium angustifolium, aecia were produced on Abies balsamea; the aeciospores thus obtained proved infective for Chamaenerium angustifolium but failed to infect Epilobium adenocaulon. The experiments revealed the difference in the choice of hosts by the fungus in the uredio- and teliospore stages.

On Pirolaceae

9. **Pucciniastrum pirolae** (Pers. apud Gmel.) Schroet. in 58. Jahresber., Schles. Ges. vaterl. Kultur, 1880, S. 167; Arth., N. Amer. Fl. VII, 1907, p. 108; 1925, p. 678, 1927, p. 818; Liro, Ured. Fenn., 1908, p. 513; Grove, Brit. Rust Fungi, 1913, p. 367, fig. 275; Trotter, Fl. Ital. Crypt. Ured. 1914, p. 383, fig. 9d, e; Syd., Monogr. Ured. III, 1915, p. 455; Fragoso, Fl. Iber. Ured. II, 1925, p. 263, fig. 130; Moss in Ann. Botany, XL, 1926, p. 835, fig. 19 et tab. XXXIV, fig. 14, 15, 40; Hirats., Monogr. Pucciniastrum, 1927, p. 68, tab. 1, fig. 9; Arth., Manual Rusts U. S. a. Canada, 1934, p. 16, fig. 25; Hirats., Monogr. Pucciniastreae, 1936, p. 219, tab. IX, fig. 1; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 310.

Syn.: **Uredo pirolae** Mart., Fl. Mosq. 1912, p. 229; Winter in Rabenhorst's Kryptog.-Fl. Deutschl. I, Die Pilze, Abth. 1 (1881), 1884, S. 254; Fischer, Ured. Schweiz, 1904, S. 539, Fig. 337; Hariot, Uréd., 1908, p. 306; Klebahn, Kryptogfl. M. Brandb. Va, 1914, S. 845, Fig. S5.

Thekopsora (?) **pirolae** Karst., Mycol. Fenn. IV, 1879, p. 59; Sacc.; Sylloge, VII, 1888, p. 866; Bubák, Rostpilze Böhmens, 1908, S. 189; Migula, Kryptog.-Fl. Deutschl. III, 1, 1910, p. 470.

232 **Aecidium pirolae** Pers. ex Gmelin in Linn., Syst. nat. II, 179 1, p. 1473.

Uredo chimaphilae Peck, Ann. Rep. N. Y. St. Mus. XLVI, 1893, p. 33; Sacc., Sylloge, XI, 1895, p. 226.

Spermagonia and aecia unknown.

Uredia amphigenous or only hypophyllous, on localized mycelium, scattered or in groups, round, small, 0.1 — 0.4 mm across, yellow or brownish-yellow, covered by hemispherical, firm peridia and the epidermis; peridial cells radially elongate, diminishing in size from the base of the peridium upward, the lower inner side increasingly thicker-walled until, at the very orifice, almost without cavities; outer walls coarsely echinulate, especially on the side facing the ostiole. Urediospores ellipsoid, elongate, or clavate, $23.4 - 41.4 \times 10.8 - 18\mu$; walls colorless, thin, echinulate; contents yellow (Figure 51).

Telia hypophyllous, inconspicuous, flat, subepidermal, forming an even layer of laterally united cells. Teliospores prismatic or columnar, $24 - 28 \times 10 - 12\mu$; walls uniformly thin, 1μ, colorless.

On species of Pirola (including Chimaphila, Moneses, Ramischia, and Erxlebenia).

General distribution: Europe, Asia (as far as Kamchatka and Japan), North America (and Greenland).

Teliospores were described by Arthur (l. c., p. 108); it is regrettable that the author did not indicate the host species and its location. We failed to find teliospores despite the thorough search on specimens from different parts of the USSR; the fungus overwinters in the uredial stage on evergreen leaves. Chrysomyxa pirolae, found also on leaves of Pirola species, is differentiated by the even hypophyllous distribution of the uredia, exposed peridium, and development on diffuse mycelium.

On **Chimaphila umbellata** (L.) Nutt. — EUROPEAN PART: U. V. (Moscow Region; W SIBERIA: Ob (Temerchinskaya woodland near Tomsk).

On **Pirola uniflora** L. (= **Moneses uniflora** Gray, **M. grandiflora** Salisb.) — EUROPEAN PART: Kar.-Lap. (Karelian ASSR; Murmansk Region: Khibiny Mts., Balt. (Estonian SSR), V.-Kama (Molotov); W SIBERIA: U. Tob. (Chkalov Region: Petropavlovskaya station); E SIBERIA: Dau. (Buryat-Mongol ASSR: Babushkin (Mysovaya station)).

On **Pirola secunda** L. incl. **P. obtusata** Turcz. (= **Ramischia secunda** Garcke) — ARCTIC: Arc. Eur. (Murmansk Region: Kil'din I.), Arc.-Sib. (Dudinka, Eniseisk); EUROPEAN PART: Kar.-Lap. (Karelian ASSR); Murmansk Region: Khibiny Mts.), Lad.-Ilm. (Leningrad Region), Balt. (Latvian SSR), U. V. (Ivanovo Region), V.-Kama (Kirov Region: Kotel'nich); W SIBERIA: Tobol'sk, Tomsk, Krasnoyarsk; E SIBERIA: Lena-Kol. (Yakutsk Region: Amga River (**P. obtusata** Turcz.)), Ang.-Say. (Balagansk (**P. obtusata** Turcz.)); FAR EAST: Kamch., Sakh. (Sakhalin I.); CENTRAL ASIA: Pam.-Al. (Kirghiz SSR: Irkeshtam at the Kashgar boundary).

On **Pirola minor** L. (= **Erxlebenia minor** Rydb.) — EUROPEAN PART: Kar.-Lap. (Murmansk Region: Khibiny Mts.) Lad.-Ilm. (Leningrad Region;
233 Kalinin Region: Kholm), Balt. (Estonian SSR, Lithuanian SSR); U. V. (Moscow Region), Crim. Nature Reserve); W SIBERIA: Irt. and Alt. (Altai); FAR EAST: Kamch.

Pirola media Sm. — EUROPEAN PART: Kar.-Lap. (Karelian ASSR), FAR EAST: Kamch., Sakh. (Kuril Is.).

On **Pirola media** Sm. var. **genuina** Herd. — FAR EAST: Sakh. (Sakhalin, Kuril Is.).

On **Pirola rotundifolia** L. — ARCTIC: Arc. Sib. (Krasnoyarsk Territory, Taimyr Subregion: Dudinka); EUROPEAN PART: Lad.-Ilm. (Leningrad Region), Balt. (Latvian SSR), U. V. (Ivanovo Region), U. Dnp. (Smolensk Region); W SIBERIA: Ob (Tobol'sk), Irt. and Alt. (Altai).

On **Pirola incarnata** Fisch. (= **P. rotundifolia** var. **incarnata** DC) — E SIBERIA: Lena-Kol. (Yakut ASSR: Aldan Plateau, Tybly-yachta station), Ang.-Say. (Minusinsk), Dau. (Buryat-Mongol ASSR: Kyakhta).

On **Pirola chlorantha** Sw. — EUROPEAN PART: Lad.-Ilm. (Leningrad Region), Balt. (Estonian SSR), V.-Don. (Kharkov; Penza Region: Kuznetsk), Crim. (Yalta), Urals (Sverdlovsk); CAUCASUS: E Transc. (Georgian SSR: Borzhomi, Gori).

On **Pirola renifola** Max. — FAR EAST: Uss. (Maritime Territory: upper reaches of the Tuncha River (in the basin of Lake Khanka)).

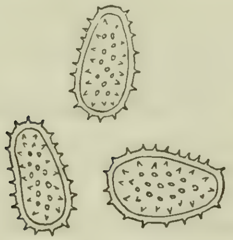


FIGURE 51. **Pucciniastrum pirolae** (Pers.) Schroet. on **Pirola minor** L. Urediospores, × 600. (Orig.)

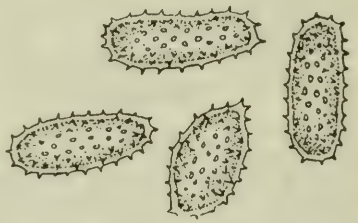


FIGURE 52. **Pucciniastrum beringianum** Tranz. on **Gentiana glauca** Pall. Urediospores, × 600. (Orig.)

On Gentianaceae

10. **Pucciniastrum ?beringianum** Tranz., Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 319.

Syn.: **Pucciniastrum alaskanum** Mains, Bull. Torrey Bot. Club, LXVI, 1939, p. 620; Arwidsson, Bot. Notiser, 1940, p. 383.

Spermatia and aecia unknown.

Uredia amphigenous, round, 0.17 — 0.35 mm across, yellow, covered by hemispherical peridium; peridial cells radially elongate at the base of peridium, isodiametric and slightly thicker at the top; the cells around the ostiole thicker-walled, smooth. Urediospores prismatic or elongate-ovoid, $24-35 \times 13-16\mu$; walls thin, colorless, echinulate (Figure 52).

Teliospores unknown.

On **Gentiana glauca** Pall. — FAR EAST: Kamch. (on Bering I. (Komandorskie Is.), collected by E. A. Kordakov, 1 July 1929; Kamchatka Peninsula; Zavoika, Mount Polovinnaya (according to Arwidsson, l. c.)). Mains (l. c.) described **P. alaskanum** on the same species in Alaska (Mount McKinley).

This fungus may be considered identical with **Pucciniastrum gentianae** Hirats. et Hashioka (Trans. Tottori Soc. Agric. Sci., V, 1935, p. 237; Hiratsuka, Monogr. Pucciniastreae, 1936, p. 283), found in Taiwan on **Gentiana formosana** Hayata, for which, however, the authors indicate almost globoid urediospores, $21-27 \times 17-23\mu$.

It is possible that this fungus found only in the uredial stage does not belong to **Pucciniastrum** but to **Cronartium**, among which two very close species are known on **Gentiana asclepiadea** in Europe and in Transcaucasia, and on **G. picta** and **G. yunnanensis** in Yunnan (China).

On Orchidaceae

234

11. **Pucciniastrum ?goodyerae** (Tranz.) Arth., N. Amer. Fl. VII, 1907, p. 105; 1927, p. 818; Liro, Ured. Fenn., 1908, p. 501; Syd., Monogr. Ured. III, 1915, p. 456; Hirats., Monogr. Pucciniastrum, 1927, p. 100, pr. p.; Arth., Manual Rusts U. S. a. Canada, 1934, p. 12, fig. 19; Hirats., Monogr. Pucciniastreae, 1936, p. 277, tab. IX, fig. 4; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 149, 150.

Syn.: **Uredo Goodyerae** Tranz., Tr. SPb. obshch. estestvoispyt., Otd. Bot. XXIII, 1893, Protok. zased., p. 27; Sacc., Sylloge, XI, 1895, p. 227.

Spermagonia and aecia unknown.

Uredia amphigenous, mostly epiphyllous, on discolored and later browning spots, single or in small groups, round, brownish-yellow, 0.2 — 0.4 mm in diameter, covered by hemispherical peridia; peridial cells narrowly oblong at the base of peridium, isodiametric toward the orifice and around the latter with extremely thickened walls below and finely verrucose above. Urediospores prismatic or ovoid, $22-36 \times 12-20\mu$, colorless, sparsely echinulate (Figure 53).

Teliospores unknown.

On species of **Goodyera**. The fungus propagates from year to year by urediospores.

General distribution: Europe (USSR, Finland, Sweden, England), North America (on **Goodyera decipiens** (Hook.) St.).

On **Goodyera repens** R. Br. (= **Peramium repens** Salisb.) — EUROPEAN PART: Lad.-Ilm. (near Leningrad (Levashovo) and in former Borovichi County near the village of Rovnoe on the Msta River).

Hiratsuka described (1936, p. 284) **Pucciniastrum ishikariense** sp. nov., found in northern Japan on **Goodyera maximowicziana** Mak., and in Taiwan on **G. nankoensis** Fukuyama. According to the author, this species is distinguished by the ellipsoid or broad-ovoid spores, 21—30 × 18—22.5 μ, with thicker (2—3 μ) and coarser echinulate walls. Hiratsuka reported this fungus earlier under the name **P. goodyerae**; the spores are described in "Monographie der Gattung Pucciniastrum" (1927, Tab. 1, Figure 12). The independence of this species raises certain doubts.

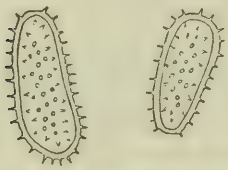


FIGURE 53. **Pucciniastrum goodyerae** (Tranz.) Arth. on **Goodyera**. Urediospores, × 600. (Orig.)

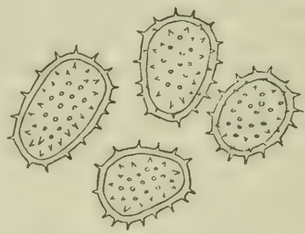


FIGURE 54. **Pucciniastrum miyabeanum** Hirats. on **Viburnum furcatum** Bl. Urediospores, × 600. (Orig.)

On Caprifoliaceae

12. **Pucciniastrum miyabeanum** Hirats., Bot. Mag. Tokyo, XII, 1898, p. 33; Rev. Mycol. XXI, 1899, p. 39; Sacc., Sylloge, XVI, 1902, p. 320; Syd., Monogr. Ured. III, 1915, p. 451; Hirats., Monogr. Pucciniastreae, 1936, p. 271, tab. VIII, fig. 3.

Biol. Hiratsuka, Japan. Journ. Bot. VI, 1932, p. 22.

Spermagonia on needles of current year, mainly hypophyllous, hemispherical, 112—156 μ across, 42—66 μ high, honey-colored. Spermatia globoid or ellipsoid to prismatic, 2.8—6.0 × 1.2—2.5 μ, colorless.

Aecia hypophyllous on leaves of current year, in 2 irregular rows on yellowish patches, cylindrical, 0.25—0.35 mm wide, 0.8—1.6 mm high;
235 peridia colorless, delicate, rupturing at the apex; peridial cells rhombic or elongate-hexagonal, overlapping, 42—63 × 15.5—21 μ; outer walls smooth, thin; inner walls thick, warted. Aeciospores globoid, ellipsoid or ovoid, 18—27 × 15—18 μ; walls sparsely echinulate, almost colorless; contents orange-yellow.

Uredia hypophyllous, scattered or in groups on yellowish spots, subepidermal, round, 0.08—0.25 mm wide, yellow; peridia hemispherical, firm, opening at the apex; peridial cells irregular-polygonal, 8—18 μ wide, smooth. Urediospores ellipsoid, ovoid, pyriform, or globoid, 18—30 × 12.6—20 μ; walls sparsely echinulate, colorless, 1.2—1.5 μ thick; contents orange-yellow (Figure 54).

Telia hypophyllous, subepidermal, usually in crowded groups bounde the veins, yellowish to yellowish-brown. Teliospores intercellular (subepidermal), in small groups, globoid or ovoid, occasionally slightly angular or depressed along the side, divided by septa into 2—6 cells, 15—25 × 15—27 μ; walls about 1 μ thick, smooth, pale yellow.

Aecia on **Abies mayriana** Miyabe et Kudo (in culture). Uredio- and teliospores on **Viburnum furcatum**. Morphologically, the fungus is close to **Pucciniastrum tiliae** Miyabe.

General distribution: USSR (Sakhalin I.), Japan (Hokkaido and Honshu Is.)

On **Viburnum furcatum** Bl. — FAR EAST: Sakh. (Sakhalin; according to Hiratsuka, 1936, pp. 271—273). Aecia were obtained by Hiratsuka in experimental cultures on leaves of **Abies mayriana**; **Larix kaempferi**, **Picea jezoensis**, **Pinus densiflora**, and **Chelidonium majus** were not susceptible to infection. Aeciospores from **Abies** produced infection on **Viburnum furcatum**, but failed to infect **Clethra barbinervis** and **Styrax japonica**.

On Saxifragaceae

13. **Pucciniastrum hydrangeae-petiolaris** Hirats., Monogr. Pucciniastrum, 1927, p. 27, tab. 1, fig. 4; Monogr. Pucciniastreae, 1936, p. 245.

Aecia unknown.

Uredia hypophyllous on yellowish or brown-discolored patches, scattered or gathered in small groups, round, 0.15—0.34 mm in diameter, yellowish-brown; peridia hemispherical, thin, firm, opening by a central pore; peridial cells radially elongate, diminishing in size toward the top, thin-walled, smooth; ostial cells round, slightly thickened above, smooth. Urediospores ovoid, ellipsoid, oblong or clavate, 18—33 × 14—21 μ; walls 1.0—1.8 μ, sparsely echinulate.

Telia amphigenous in crowded groups bounded by the veins, yellowish-brown. Teliospores subepidermal, intercellular, single or in groups, globoid, ovoid or prismatic, consisting of 2—4 cells, rarely more, 19.8—32.4 × 18—27 μ; walls about 1 μ thick, smooth, pale yellowish to brown.

236 On species of **Hydrangea** in the USSR (Sakhalin) and in Japan.

On **Hydrangea petiolaris** Sieb. et Zucc. — FAR EAST: Sakh. (Sakhalin I.; according to Hiratsuka, 1936).

Thekopsora hydrangeae (B. et C.) Magn. is encountered on **Hydrangea arborescens** L. in the eastern states of North America. The Japanese species is distinguished from this by development of teliospores subepidermally — but not inside the epidermis cells — and by larger urediospores.

6. Genus THEKOPSORA P. Magnus

P. Magn., Sitzungsber, Ges. Naturf. Fr. Berlin, 1875, S. 58; Hedwigia, XIV, 1875, S. 123.

Syn.: **Pucciniastrum** auct. pr. p.

Distinguished from genus **Pucciniastrum** only by the development of teliospores intraepidermally, intracellularly. This may be seen in transverse sections of leaves with teliospores; the teliospore location can be ascertained also in clarified leaf fragments: if the spores appear restrained by the lateral walls of the epidermal cells, then they develop inside the cells; if some spores lie under the lateral walls of the epidermal cells, as if covered by them, the spores lie under the epidermis.

Fifteen species are known, of which 8 from the USSR.

Key to Species of **Thekopsora**

I. Urediospores with colorless contents, white. Aecia on the upper and under (inner) sides of the scales of spruce cones, hemispherical, with firm almost liquified brown peridia opening by a transverse slit. Uredio- and teliospores on species of **Prunus**, family **Rosaceae**.
   A. Urediospores mostly $18 \times 12-15\mu$ . . . . 1. **T. areolata** (Fr.) Magn.
   B. Urediospores mostly $23-25 \times 15-16\mu$ . . . . 2. **T. pseudocerasi** Hirats.

II. Urediospores with yellow contents. Aecia, if present, on needles, with white peridia and pigmented aeciospores.
   A. On representatives of family **Ericaceae**.
      1. Ostiolar cells of peridia smooth. Urediospores $16-24\mu$ long . . . . 3. **T. myrtilli** (Schum.) Tranz.
      . . . . 4. **T. ericae** (Naum.) Tranz.
      2. Ostiolar cells of peridia echinulate. Urediospores $26-45\mu$ long. . . . . 5. **T. sparsa** (Winter) Magn.
   B. On representatives of family **Boraginaceae**. 6. **T. brachybotrydis** Tranz.
   C. On representatives of family **Rubiaceae**.
      1. On species of genus **Rubia** . . . . 7. **T. rubiae** Kom.
      2. On species of genus **Galium** . . . . . 8. **T. galii** (Link) De-T.
   D. On representatives of family **Compositae**. . . . . 9. **T. asteris** Tranz.

On **Prunoides** (**Rosaceae**)

1. **Thekopsora areolata** (Fr.) Magn., Sitzungsber. Ges. Naturf.
237 Fr. Berlin, 1875, S. 58; Hedwigia, XIV, 1875, S. 123; Sacc., Sylloge, VII, 1888, p. 764; Klebahn, Kryptogfl. M. Brandb. Va, 1914, S. 836, Fig. S1; Syd., Monogr. Ured. III, 1915, p. 459; Fragoso, Fl. Iber. Ured. II, 1925, p. 265, fig. 131; Hirats., Monogr. Pucciniastreae, 1936, p. 297, tab. XI, fig. 1.

Syn.: **Sclerotium areolatum** Fries, Syst. Mycol. II, 1822, p. 263.

Pucciniastrum areolatum Otth in Wartmann u. Schenk, Schweiz. Cryptog. No. 251, 1863; Trotter, Fl. Ital. Crypt. Ured., 1914, p. 386, fig. 96.

Thekopsora padi (Schum. et Kunze) Kleb., Jahrb. wiss. Bot. (Pringsheim's) XXXIV, 1900, S. 378; XXXV, 1901, S. 695, Fig. V, VI, VII; Bubák,

Rostpilze Böhmens, 1908, S. 187, Fig. 45; Migula, Kryptog.-Fl. Deutschl. III, 1, 1910, S. 469, XC, Fig. 3, 4; Grove, Brit. Rust Fungi, 1913, p. 368, fig. 276; Kuprewicz, Tr. Bot. Inst. AN SSSR, ser. II, 1, 1933, p. 405—408; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 225, 236.

Pucciniastrum padi Diet. in Engler u. Prantl, Nat. Pflanzenfam. I, Abt. 1**, 1897, S. 47, Fig. 53C, D; Fischer, Ured. Schweiz, 1904, S. 463, Fig. 303; Hariot, Uréd., 1908, p. 252; Liro, Ured. Fenn., 1908, p. 503.

Uredo padi Schum. et Kunze, Deutschl. Schwämme, VIII, No. 187 (exs.), 1817 (Sine descript. specimene viso).

In the herbarium of the Botanical Institute of AN SSSR there is a specimen labeled "No. CLXXXVII, Uredo Padi Nobis" with a handwritten inscription by Winkler, "Schmidt et Kunze: Deutschlands Schwämme VIII." It is not known whether this collection was supplemented with a list of new species described in it; if not, **Uredo padi** Schum. et Kunze has no priority over **Sclerotium areolatum** Fries, and the fungus should be designated **Thekopsora areolata** (Fr.) P. Magnus.

Aecidium strobilinum (Alb. et Schw.) Rees. Abhandl. Naturf. Ges. Halle, XI, 1869, S. 105; Sacc., Sylloge, VII, 1888, p. 824.

Pucciniastrum strobilinum Liro, Ured. Fenn., 1908, p. 503.

Thekopsora strobilina Jørst., Medd. norske Skogforsøksvesen, VI, 1925, p. 82.

Biol. Klebahn, Jahrb. wiss. Bot. XXXIV, 1900; XXXV, 1905; Ztschr. Pflanzenkr. XVII, 1907, S. 150—152, Fig. 4, 5; Tubeuf, Arb. Biol. Abt. Land- u. Forstwirtsch. II, 1, 1901, S. 164—166, Fig. 1—5; II, 2, 1902, S. 365—366; Fischer, Ber. Schweiz. bot. Ges. XII, 1902, S. 8; Centrbl. Bakteriol. II. Abt., XV, 1905, S. 228; Vanin, Lesn. fitopatol., 1934, p. 235—237.

Spermagonia form crusts of various sizes which unite or converge in diverse shapes on the outer side of the scales, only in those sites that protect the next lower scale, from 70μ to 3—4 mm. Spermagonia consist of parallel long sterigmata constricted by the round spermatia and scattered between the cells of the epidermis and cuticle which ultimately rupture. Aecia crowded on all scales of the infected spruce cones, almost covering the underside of the scales, mainly the inner surface; peridia short, cylindrical or hemispherical, rounded at the top, firm, brown, ligneous, rupturing crosswise in the spring, and then bowl-shaped; peridial cells in radial section, $22-30\mu$ high, $22-25\mu$ thick, almost devoid of interspaces as a consequence of the extreme thickening of the outer walls (up to $17-22\mu$); the inner walls thin, 3μ, verrucose. Aeciospores ellipsoid, $21-28\times 17-20\mu$; wall thick, coarsely verrucose, with longitudinal quite smooth stripes, colorless; spore masses brownish to gray.

238 Uredia hypophyllous, in small groups on angular patches; red on bird cherry, light green or brownish on cherry, white, but appearing light pink on the red spots; peridia hemispherical covered by the epidermis, of thin-walled, angular cells; ostiolar cells higher, thick-walled, often without a lumen, smooth. Urediospores prismatic-ellipsoid or ovoid, $15-25 \times 10-18\mu$ (usually $18\times 14.5\mu$); spore wall colorless, rarely echinulate; contents colorless (Figure 55).

Telia mainly hypophyllous forming dark brown patches delimited by the veins. Teliospores intracellular, intraepidermal, subgloboid or, following mutual pressure, prismatic, up to 25μ across, dividing longitudinally into

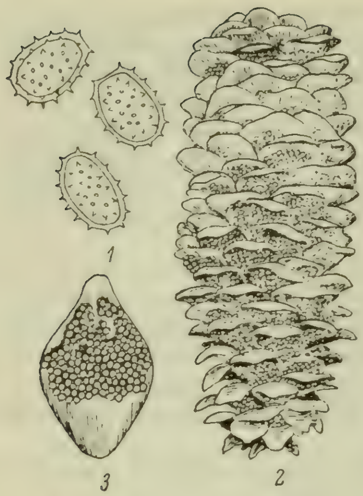


FIGURE 55. **Thekopsora areolata** (Fr.) Magn.:

1 – urediospores on **Padus racemosa** (Lam.) Gilib., × 600 (Orig.); 2 – cone with aecia on **Picea vulgaris** Link; 3 – scale of cone with aecia. (After Engler)

2–4 cells; walls light brown, darker and thickened above, up to 2–3 μ, with a pore in the inner corner (in relation to each spore) of each cell. Basidia up to 50 μ long, 4 μ thick. Basidiospores globoid, about 3 μ across.

Aecia on **Picea**. Uredio- and teliospores on **Padus** (**Prunus**). The fungus is widespread in the USSR. In Europe the fungus occasionally infects the American bird cherry, **Padus serotina** Ag. (= **Prunus serotina** Ehrh.), **P. virginiana** (L.) Mill., cherry, and mazzard. The fungus occurs in S Sakhalin on the local bird cherry, **Padus** (**Prunus**) **Ssiori** Fr. Schm., and also on the Japanese island of Hokkaido. The aecia open in the spring and the aeciospores infect the young leaves of bird cherry on which they produce uredia and, in fall, also telia. In the spring the teliospores germinate and the basidiospores infect young spruce cones; the mycelium spreads through the axis of the cone and of all scales, on the latter developing spermagonia in June and aecia in fall. Young leaf-bearing shoots have been successfully infected experimentally, whereupon in individual cases spermagonia and aecia also developed on them.

General distribution: most of Europe and Asia (as far as Japan and Korea).

On **Picea excelsa** Link – EUROPEAN PART: Kar.-Lap. (Karelian ASSR), Dv.-Pech. (Syktyvkar), Lad.-Ilm. (Leningrad Region), Balt. (Estonian SSR, Latvian SSR, Lithuanian SSR), U. V., V.-Kama, U. Dnp., U. Dns.

On **Picea obovata** Ledeb. – EUROPEAN PART: V.-Kama (Molotov Region); W SIBERIA; E SIBERIA.

On **Picea jezoensis** Carr. (= **P. ajanensis** Fisch.) – FAR EAST: Kamch., Uss. (Maritime Territory).

On **Padus racemosa** (Lam.) Gilib. incl. **P. asiatica** Kom. (= **Prunus padus** L.) – EUROPEAN PART: Kar.-Lap., Dv.-Pech., Lad.-Ilm., Balt. (Estonian SSR, Latvian SSR, Lithuanian SSR), U. V., V.-Kama, U. Dnp., M. Dnp., U. Dns., V.-Don (Voronezh Region, Kuibyshev Region (in the absence of
239 spruce ?)), Transv.; CAUCASUS; W SIBERIA: Ob, Irt., Alt.; E SIBERIA: Dau. (Buryat-Mongol ASSR: Kyakhta); FAR EAST: Uss. (Maritime Territory).

On **Padus maackii** (Rupr.) Kom. – FAR EAST: Uss. (Maritime Territory).

On **Padus ssiori** Fr. Schm. – FAR EAST: Sakh. (S Sakhalin).

On **Cerasus vulgaris** Mill. (= **Prunus cerasus** L.) – EUROPEAN PART: Lad.-Ilm. (Leningrad Region: Krasnye Gory on the Luga River, Batovo on the Oredezhe River, V.-Don (Kuibyshev Region: Syzran).

On **Cerasus fruticosa** (Pall.) G. Woron. (= **Prunus fruticosa** Pall., **P. chamaecerasus** Jacq.) – EUROPEAN PART: V.-Don (Kuibyshev Region: Syzran).

On Amygdalus nana L. (= Prunus nana (L.) Stokes) — EUROPEAN PART: V.-Don (Kuibyshev Region: Syzran).

The connection between the two host plants has been experimentally demonstrated by Klebahn (1900, 1901) who infected with aeciospores young spruce shoots in which mycelia were later found, but no spermagonia and aecia. Tubeuf (1901, 1902) succeeded in infecting leaves of bird cherry with aeciospores from overwintered aecia, while Klebahn, in subsequent experiments, reported hypertrophy of the stems in two-year-old spruce seedlings, on which three normal aecia had developed. Fischer (1905) and Klebahn (1907) demonstrated the presence of spermagonia and aecia on cone scales, and spermagonia on spruce shoots following experimental infections with basidiospores.

The fungus inflicts severe losses to the forest economy. It can be controlled by extermination of the intermediate host: the bird cherry (see Vanin, 1934).

2. **Thekopsora pseudocerasi** Hirats., Journ. Faculty Agric. Hokkaido Univ. XXI, 1927, p. 16; Kuprewicz, Tr. Bot. Inst. AN SSSR, ser. II, 1, 1933, p. 405—408; Hirats., Monogr. Pucciniastreae, 1936, p. 296; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 236.

Spermagonia and aecia unknown; apparently on spruce cones.

Uredia hypophyllous on yellow-brown spots, scattered or in groups, small, 0.1 — 0.4 mm across; peridia hemispherical, covered by the epidermis, of small cubical cells; ostiolar cells thick-walled, smooth. Urediospores ovoid, ellipsoid or oblong, $19-31 \times 12-18\mu$ (usually, $23-25 \times 15-16\mu$); outer wall colorless, echinulate; contents colorless.

Telia mainly epiphyllous forming purple or brown spots delimited by the leaf veins. Teliospores intraepidermal, 2- to 4-celled, pale brown, smooth, $16-17\mu$ across, $23.4-28.8\mu$ long (Figure 56).

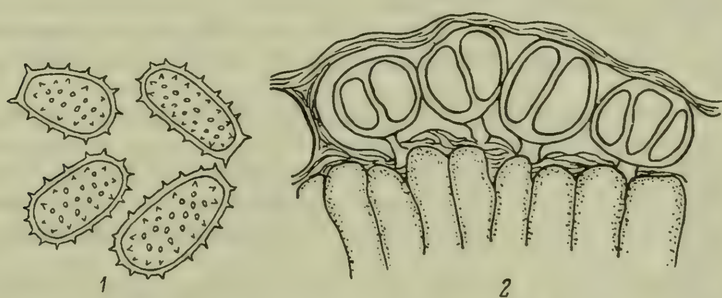


FIGURE 56. Thekopsora pseudocerasi Hirats.:

1 — urediospores on **Cerasus vulgaris** Mill.; 2 — teliospores on **C. sachalinensis** (Fr. Schm.) Kom. et Klob.-Alis., × 600. (Orig.)

The fungus was described from specimens on the Japanese island of Hokkaido on the Sakhalin cherry — **Cerasus sachalinensis** (Fr. Schm.) Kom. et Klob.-Alis. (= **Prunus serrulata** Lindl. (= **P. pseudocerasus** hort. non Lindl.) var. **sachalinensis** Mak.) and on the common orchard cherry;

also on undefined species of **Amygdalaceae** (peach trees ?) in Voroshilov and Vladivostok. This species is differentiated from **Thekopsora padi** by the larger urediospores (see Kuprewicz, 1933).

General distribution: USSR (Far East), Japan.

On **Cerasus vulgaris** Mill. (= **Prunus cerasus** cult.) — FAR EAST: Uss. (Maritime Territory: Okeanskaya station (in orchard)).

On **Cerasus fruticosus** (Pall.) G. Woron. — FAR EAST: Ze.-Bu. (Arkhara station, in orchard).

On **Cerasus sachalinensis** (Fr. Schm.) Kom. et Klob.-Alis. — FAR EAST:
240 Uss. (Anuchinskii Pass).

Pathogenicity of this fungus unknown. In years of outbreak it may lower the yield of infected trees following partial premature death of the leaves.

On **Ericaceae**

3. **Thekopsora myrtilli** (Schum.) Tranz., Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 311, 312.

Syn.: **Aecidium ? myrtilli** Schum., Enum. plant. Saeland. II, 1803, p. 227.

Thekopsora myrtillina Karst., Mycol. fennica, IV, in Bidr. K. Finl. Natur ad Folk, XXXI, 1879, p. 59, Klebahn, Kryptogfl. M. Brandb. Va, 1914, p. 843; Hirats., Journ. Facul. Agric. Hokkaido Univ. XXI, 1, 1927, p. 19; Hirats., Monogr. Pucciniastreae, 1936, p. 306, tab. 9, fig. 6.

Pucciniastrum myrtilli (Schum.) Arth., Résult. scient. Congr. bot. Vienne, 1905, 1906, p. 337; N. Amer. Fl. VII, 1907, p. 109; 1925, p. 678; 1927, p. 818; Manual Rusts U. S. a. Canada, 1934, p. 18, fig. 28.

Uredo vacciniorum DC, Fl. franç. VI, 1815, p. 85.

Thekopsora vacciniorum (DC) Karst., l. c., 1879, p. 58; Sacc., Sylloge, VII, 1888, p. 765; Bubák, Rostpilze Böhmens, 1908, S. 188; Migula, Kryptog.-Fl. Deutschl. III, 1, 1910, S. 470; Grove, Brit. Rust Fungi, 1913, p. 371, fig. 277; Klebahn, Kryptogfl. M. Brandb. Va, 1914, S. 840, Fig. G3; Fragoso, Fl. Iber. Ured. II, 1925, p. 268, fig. 132; Moss, Ann. Botany, XL, 1926, p. 836, fig. 20, tab. XXXIV, fig. 6; Hirats., l. c., 1927, p. 325; l. c., 1936, p. 325.

Pucciniastrum vacciniorum (DC) Lagerh., Tromsö mus. Aarsheft, XVII, 1895, p. 93; Liro, Ured. Fenn., 1908, p. 515.

Pucciniastrum vacciniorum (DC) Diet. in Engler u. Prantl, Nat. Pflanzenfam. I, Abt. 1**, 1897, S. 47; Fischer, Ured. Schweiz, 1904, S. 467, Fig. 305; Hariot, Uréd., 1908, p. 252; Trotter, Fl. Ital. Crypt. Ured., 1914, p. 252.

Uredo minima Schw., Schrift. Nat. Ges. Leipzig, I, 1822, S. 70.

Thekopsora minima Syd., Monogr. Ured. III, 1915, p. 465.

Pucciniastrum minimum (Schum.) Arth., Résult. scient. Congr. bot. Vienne, 1905, 1906, p. 337; N. Amer. Fl. VII, 1907, p. 109; 1925, p. 678;
241 1927, p. 818.

Peridermium peckii Thüm., Mitt. Forstl. Vers. Oester. II, 1880, S. 320; Arth. a. Kern, Bull. Torrey Bot. Club, XXXIII, 1906, p. 433; Adams, Pennsylvania St. Coll. Agric. Exper. Sta. Bull. No. 160, 1919, p. 52, fig. 5, 6, tab. 1, fig. 2 (var. nov.).

Aecidium peckii Diet. in Engler u. Prantl, Nat. Pflanzenfam. I, Abt. 1**, 1897, S. 78.

Biol. Clinton, Rep. Conn. Agric. Exper. Sta. 1909—1910, 1911, p. 719; Fraser, Mycologia, IV, 1912, p. 184; V, 1913; p. 237; VI, 1914, p. 27.

Spermagonia hypophyllous, numerous, scattered, intercellular in the epidermis, inconspicuous, low, flat, small, 65—125μ wide, 20—26μ high.

Aecia hypophyllous, on local mycelium, in 2 rows on yellow patches involving part or, usually, the entire leaf, cylindrical, small, 0.2—0.3 mm across, 0.5—1.0μ high; peridium readily falling apart; peridial cells delicate, slightly overlapping, outer walls very thin, smooth, inner walls 4—5μ thick, moderately verrucose. Aeciospores globoid or broad-ellipsoid, 18—27 × 15—21μ; outer walls colorless, thin, 1—1.5μ, finely and evenly verrucose.

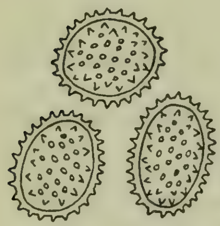


FIGURE 57. **Thekopsora myrtilli** (Schum.) Tranz. on **Vaccinium myrtillus** L. Urediospores, × 600. (Orig.)

Uredia hypophyllous, scattered or in groups, round, yellowish-brown; peridia hemispherical, covered by the epidermis, of small, smooth cells; ostiolar cells of peridium higher, rather thickened, smooth, gradually shorter and thinner-walled toward the peridial base. Urediospores ovoid, ellipsoid or subgloboid, 16—30 × 13—19μ; outer wall colorless, rarely echinulate; contents yellow (Figure 57).

Telia hypophyllous, small, brown. Teliospores intracellular intraepidermal, globoid to ellipsoid, 14—23μ across, longitudinally dividing into 2—4 cells; outer wall smooth, evenly punctate, light yellow.

On species of **Vaccinium** in Europe, Asia (as far as the Kuril Is. and Kamchatka), and North America. In North America also on other genera: **Oxycoccus, Gaylussacia, Andromeda (Pieris, Xolisma), Menziesia, Rhodora, Azalea.** Aecia on **Tsuga**. Hiratsuka, Journ. Facult. Agric. Hokkaido Univ., XXI, 1927, p. 18 ff., distinguished, according to Karsten, the fungus on **Vaccinium vitis-idaea** with the larger uredia (0.21—0.55 mm across) from fungi on other species of **Vaccinium** (0.1—0.21 mm across), designating the first **Thekopsora vacciniorum** Karsten, and the second, **Thekopsora myrtillina** Karsten; differentiation of the species by these features seems inadequate, and was not considered possible by Klebahn (1914).

Apparently, no aecia have been detected in the USSR.

On **Vaccinium myrtillus** L. — EUROPEAN PART: Kar.-Lap., Dv.-Pech., Lad.-Ilm. Balt., U. V., V.-Kama, U. Dnp., U. Dns.; CAUCASUS: E Transc.; W SIBERIA: Ob, Alt.; E SIBERIA: Ang.-Say.; FAR EAST: Kamch.

242 On **Vaccinium uliginosum** L. — EUROPEAN PART: Kar.-Lap., Balt., Dv.-Pech., Lad.-Ilm., U. V., U. Dnp., U. Dns.; W SIBERIA: Ob; FAR EAST: Sakh. (S Sakhalin, Kuril Is.).

On **Vaccinium vitis-idaea** L. — EUROPEAN PART: Kar.-Lap., Lad.-Ilm., Balt. (Estonian SSR, Latvian SSR), U. Dns.; W SIBERIA: Tomsk; E SIBERIA: Lena-Kol., Ang.-Say.; FAR EAST: Kamch., Sakh. (Sakhalin and Kuril Is.).

On **Vaccinium hirtum** Thunb. — FAR EAST: Sakh. (S Sakhalin).

The connection of the fungus with the aecia on **Tsuga canadensis** (L.) Carr. (= **Abies canadensis** Mich.) in eastern North America was detected by Clinton (1911) who conducted successful experimental infections of **Gaylussacia baccata** (Wang.) C. Koch with aeciospores from **Tsuga**. Fraser (1913) obtained spermagonia and aecia on leaves of **Tsuga canadensis**

infected with teliospores from Vaccinium canadense Kalm., and in the following year (l.c., 1914) obtained the same results with teliospores from Gaylussacia baccata (= G. resinosa T. et G.). Fraser infected Tsuga canadensis and Abies balsamea with teliospores of the fungus from Rhodora canadensis (L.) (Thekopsora minima Syd.), whereupon spermagonia and aecia were produced on the leaves and cones of Tsuga but not of Abies (Fraser, 1912). Experimental infections with this fungus were not performed in Europe.

4. **Thekopsora ericae** (Naum.) Tranz. Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 312.

Syn.: Uredo ericae A. Naum., Jahresb. Ver. angew. Botanik, IX, (1911) 1912, S. 207, Fig. 4; Syd., Monogr. Ured. IV, 1924, p. 439.

Pucciniastrum ericae (Naum.) Cumm., Mycologia, XXVII, 1935, p. 613.

Thekopsora? Fischeri P. Cruch., Bull. Soc. Vaud. sci. natur. LI, 189, 1916, p. 77, fig. 3, 4; Sacc., Sylloge, XXIII, 1925, p. 845; Fragoso, Fl. Iber. Ured. II, 1925, p. 271, fig. 134.

Spermagonia and aecia unknown.

Uredia hypophyllous or amphigenous, yellow, minute, 0.13 — 0.15 mm (according to Sydow, 0.6 mm), covered by hemispherical peridia consisting of small, thick-walled, smooth cells, larger at the ostiole. Urediospores irregularly ovoid or globoid, $18-25 \times 12-17\,\mu$; outer walls thin, echinulate; pores invisible (according to Cummins — 8 scattered pores);

Teliospores unknown.

On Calluna vulgaris (L.) Hill., in one place in Switzerland; on Erica ciliaris L., in Spain; on cultivated species of Erica (E. gracilis Wendl., and E. hyemalis Nichols) in Germany, on the latter also in California; on E. cinerea L., in France.

The possibility exists of importation into the USSR.

5. **Thekopsora sparsa** (Winter) Magn. in Dalla Torre u. Sarnth., Fl. Tirol, III, Pilze, 1905, p. 118; Migula, Kryptog.-Fl. Deutschl. III, 1, 1910, S. 470, Taf. XD, Fig. 1—3; Klebahn, Kryptogfl. M. Brandb. Va, 1914, S. 844; Syd., Monogr. Ured. III, 1915, p. 464, tab. XX, fig. 162; Fragoso, Fl. Iber. Ured. II, 1925, p. 269, fig. 133; Hirats., Journ. Facult. Agric. Hokkaido Univ. XXI, 1927, p. 24; Hirats., Monogr. Pucciniastreae, 1936, p. 286; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 311, 312.

Syn.: Pucciniastrum sparsum (Winter) Fisch., Ured. Schweiz, 1904,
243 S. 469, Fig. 133; Arth., N. Amer. Fl. VII, 1907, p. 108; 1925, p. 678; 1927, p. 814, 818; Hariot, Uréd., 1908, p. 249; Liro, Ured. Fenn., 1908, p. 520; Trotter, Fl. Ital. Crypt. Ured., 1914, p. 385; Arth., Manual Rusts U.S. a. Canada, 1934, p. 17, fig. 27.

Melampsora sparsa Winter in Rabenhorst's Kryptog.-Fl. I, 1881, S. 245; Sacc., Sylloge, VII, 1888, p. 225.

Biol. Ed. Fischer, Mitt. Naturf. Ges. Bern, (1916) 1917, p. 127—134, pr. p.

Spermagonia subcuticular, flat, $70-100\,\mu$ across, $35\,\mu$ high.

Aecia produce almost no discoloration of the attacked leaf areas, cylindrical or slightly compressed, up to 0.5 mm high, opening sometimes through a cap; peridial cells with inner walls up to $5\,\mu$ thick, surface finely punctate, striped in section, and with very thin, smooth outer walls.

Aeciospores globoid or ellipsoid, 21 — 23 × 18 — 25 μ; outer walls colorless, densely verruculose, with smooth areas; contents orange-yellow (according to Fischer).

Uredia hypophyllous on red spots, scattered or in groups, orange-yellow, covered by hemispherical peridia; peridial cells becoming gradually higher toward the ostiole and their inner walls thicker; ostiolar cells considerably thickened, echinulate at their upper outer margin. Urediospores ellipsoid or clavate, 28 — 42 × 14 — 18 μ; outer wall thin, sparingly echinulate, colorless; contents orange-yellow (Figure 58).

Telia mostly epiphyllous, black-brown. Teliospores intracellular in the epidermis, ellipsoid or subgloboid, dividing longitudinally into 4 — 8 cells, 24 — 35 μ across; walls brown, thickened above, up to 6 μ; pore in each cell at the site of intersection with the longitudinal septum of the teliospore.

Badisiospores globoid, 7.0 — 8.5 μ across.

Aecia on **Picea**. Uredio- and teliospores on species of **Mairania**. To the same species belong the fungi parasitic on **Arbutus** and **Arctostaphylos**, in western North America, and on the bearberry (**Arctostaphylos uva-ursi** (L.) Spr.) in Europe; on the latter only the uredial stage is known. In the Khibiny Mountains Tranzschel found severely infected specimens of **Mairania alpina** growing side by side with unaffected **Arctostaphylos**.

General distribution: mountains of Central Europe, Arctic regions of Europe, Asia and northwestern North America, USSR (Sakhalin I., Kuril Is.), and Japan (Hokkaido).

On **Picea excelsa** Link — aecia in culture.

On **Mairania alpina** (L.) Desv. (= **Arctostaphylos alpina** Spreng., A. alpina Niedenzu) — EUROPEAN PART: Kar.-Lap. (Murmansk Region; Vudyarvchorr in the Khibiny Mts.); W SIBERIA: Irt. (Omsk Region: Manya River); E SIBERIA: Lena-Kol. (Yakut ASSR: former Vilyuisk Subregion).

On **Mairania (Arctous) japonica** Nakai — FAR EAST: Sakh. (Sakhalin I., Kuril Is.: Urup, Matsuba).

On **Arctostaphylos uva-ursi** (L.) Spreng. — EUROPEAN PART: Kar.-Lap.
244 (Karelian ASSR: Suoyarvi), Lad.-Ilm. (Tolmachevo, on the Luga River).

Basidiospores from **Mairania alpina** produced aecia on **Picea**, in experimental sowings carried out by Fischer in Switzerland.

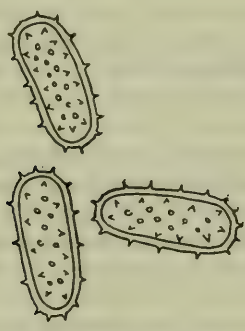


FIGURE 58. **Thekopsora sparsa** (Winter) Magn. on **Mairania alpina** (L.) Desv. Urediospores, × 600. (Orig.)

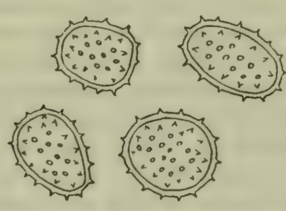


FIGURE 59. **Thekopsora brachybotrydis** Tranz. on **Trigonotis radicans** (Maxim.) Gürcke. Urediospores, × 600. (Orig.)

On **Boraginaceae**

6. **Thekopsora brachybotrydis** Tranz., Ann. mycol. V, 1907, p. 551; Sacc., Sylloge, XXI, 1912, p. 734; Syd., Monogr. Ured. III, 1915, p. 469; Hirats., Monogr. Pucciniastreae, 1936, p. 316; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 325.

Spermagonia and aecia unknown.

Uredia hypophyllous, scattered or loosely grouped, yellowish-brown, covered by hemispherical peridia, 180 — 380 μ across; peridial cells elongate at the base and rounded at the apex and around the ostiole, brownish, thin-walled, smooth. Urediospores ovoid or ellipsoid, frequently angular, 17 — 20 × 14 — 17 μ; walls colorless, echinulate; contents yellow (Figure 59).

Telia of indefinite shape, hypophyllous, brown. Teliospores intraepidermal, intracellular, dividing longitudinally into 2 — 4 cells, angular because of mutual pressure, 20 — 27 μ across, brown.

Uredio- and teliospores on **Brachybotrys paradiformis** Maxim., in Manchuria and the USSR (Maritime Territory); on **Trigonotis radicans** (Maxim.) Gürcke in the USSR (Maritime Territory); on **Brunnera sibirica** Stev. in the USSR (Altai); on **T. brevipes** (Maxim.) and on **Myosotis palustris** (L.) Hill. in Japan.

On **Brachybotrys paradiformis** Maxim. — FAR EAST: Uss. (along the Kamenushka River in the Suputinka River basin and in the Manchugal River valley).

On **Trigonotis radicans** (Maxim.) Gürcke — FAR EAST: Uss. (along the upper Maikhe River in the Shkotovo District, and near Sitsa village in the Suchan District).

On **Brunnera sibirica** Stev. (= **Anchusa myosotidiflora** Lehm. var. grandiflora DC) — W SIBERIA: Alt. (Altai, valley of the Pyzha River, flowing into the Biya River below Lake Teletskoe).

On **Rubiaceae**

7. **Thekopsora rubiae** Kom. in Jacz., Kom. et Tranz., Fungi Rossiae exs. No. 328, 1899; Kom., Hedwigia, XXXIX, 1900, S. (128); Sacc., Sylloge, XVI, 1902, p. 321; Syd., Monogr. Ured. III, 1915, p. 468; Hirats., Monogr. Pucciniastreae, 1936, p. 317, tab. X, fig. 6; tab. XI, fig. 6; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 343.

Syn.: **Uredo rubiae** Diet., Engler's Bot. Jahrb. XXVIII, 1900, S. 290.

Spermagonia and aecia unknown.

Uredia hypophyllous, scattered, yellow, gradually becoming almost black owing to browning of the integument; covered by hemispherical peridia, 0.1 — 0.3 mm across; peridial cells elongate at the base, ostiolar cells wider and thicker, (2 — 4 μ thick), smooth. Urediospores subgloboid, ovoid or ellipsoid, 17 — 25 × 13 — 17 μ; walls colorless, echinulate; contents yellow (Figure 60).

245 Telia small, thickly set, confluent, arborescent, dark brown to black. Teliospores intraepidermal, intracellular, numerous, owing to mutual pressure, angular-globoid, or globoid-ellipsoid, 2- to 5-celled, dark brown, 25 — 35 μ across.

On **Rubia cordifolia** L. and **R. chinensis** Regel.

General distribution: Far East (USSR, China, Manchuria, Japan).

On **Rubia chinensis** Regel (only uredial stage) — FAR EAST: Uss. (Maritime Territory: near Vladivostok and in the Shkotovo and Suchan districts).

On **Rubia cordifolia** L. var. **pratensis** Maxim. (only uredial stage) — FAR EAST: Uss. (near Vladivostok, and in the Shkotovo and former Pos'et districts).

On **Rubia cordifolia** L. var. **silvatica** Maxim. (II and III) — FAR EAST: Uss. (near Vladivostok and in the Shkotovo and former Pos'et districts).

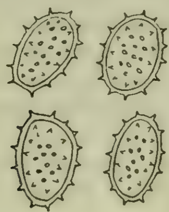


FIGURE 60. **Thekopsora rubiae**. Kom. on **Rubia chinensis** Regel. Urediospores, × 600. (Orig.)

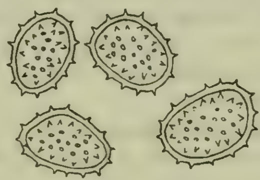


FIGURE 61. **Thekopsora galii** (Link) De-T. on **Galium mollugo** L. Urediospores, × 600. (Orig.)

8. **Thekopsora galii** (Link) De-T. in Sacc., Sylloge, VII, 1888, p. 765; Bubák, Rostpilze Böhmens, 1908, S. 108; Migula, Kryptog.-Fl. Deutschl. III, 1, 1910, S. 469, Taf. XD, Fig. 4, 5; Grove, Brit. Rust Fungi, 1913, p. 370; Klebahn, Kryptogfl. M. Brandb. Va, 1914, S. 839, Fig. S2; Fragoso, Fl. Iber. Ured. II, 1925, p. 272, fig. 135; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 341, 343.

Syn.: **Pucciniastrum galii** (Link) Fisch., Ured. Schweiz, 1904, S. 471, Fig. 307; Hariot, Uréd., 1908, p. 251; Liro, Ured. Fenn., 1908, p. 521; Trotter, Fl. Ital. Crypt. Ured., 1914, p. 385; Arth., N. Amer. Fl. VII, 1925, p. 679; Arth., Manual Rusts U. S. a. Canada, 1934, p. 19, fig. 29.

Caeoma galii Link in Willdenow, Spec. plant. VI, 2, 1925, p. 21.

Thekopsora guttata (Schroet.) Syd., Monogr. Ured. III, 1915, p. 467; Hirats., Monogr. Pucciniastreae, 1936, p. 320.

Melampsora guttata Schroet., Abhandl. Schles. Ges. vaterl. Cult. 1869—72, 1872, S. 26.

Spermagonia and aecia unknown.

Uredia hypophyllous, scattered or in small groups, yellow, small, 0.1 — 0.2 mm across, invested in hemispherical peridia and covered by the epidermis; peridial cells prismatic, upper peridial cells cubical. Urediospores globoid-ellipsoid or ovoid, 16 — 20 × 10 — 15 μ; wall colorless, rarely echinulate (Figure 61).

Telia small, dark brown. Teliospores intraepidermal, globoid or, following mutual pressure, prismatic, divided longitudinally into 2 — 4 cells, 21 — 32 μ across; wall light brown.

On **Gallium, Asperula, Sherardia** in Europe, Asia, and North America.

On **Asperula odorata** L. — EUROPEAN PART: U. Dnp. (Belorussian SSR: Bialowieza Forest); W SIBERIA: Alt. (Kolyvanskoe village).

On **Asperula maximowiczii** Kom. (= **A. platygalium** var. **pratensis** Max.)— FAR EAST: Uss. (near Vladivostok).

On **Galium verum** L. (incl. **G. ruthenicum** M. B.) — EUROPEAN PART: Balt. (Estonian SSR), U. Dnp. (Kiev Region), U. Dns. (Drogobych Region), M. Dnp. (Kursk Region), V. -Don (Kuibyshev Region: Syzran; Kharkov Region), L.-Don (Saratov); CAUCASUS: E Transc. (Tbilisi, Likany); W SIBERIA: Ob (Tobol'sk), Alt. (Kolyvanskoe village).

On **Galium mollugo** L. (incl. **G. erectum** Huds.)— EUROPEAN PART: Balt. (Estonian SSR), Lad.-Ilm. (Leningrad Region), U.V. (Ivanovo Region), V. -Kama (Kirov Region), U. Dnp. (Smolensk Region), M. Dnp. (Chernigov Region), Crimea.

On **Galium uliginosum** L. — EUROPEAN PART: Lad.-Ilm. (Leningrad Region), U.-Dnp. (Smolensk Region).

On **Galium dahuricum** Turcz. — FAR EAST: Uss. (Vladivostok and Voroshilov areas).

On **Galium paradoxum** Max. — FAR EAST: Ze.-Bu. (Amur Region: Mount Landoko on the Kyrma River), Uss. (Maritime Territory: upper reaches of the Maikhe River).

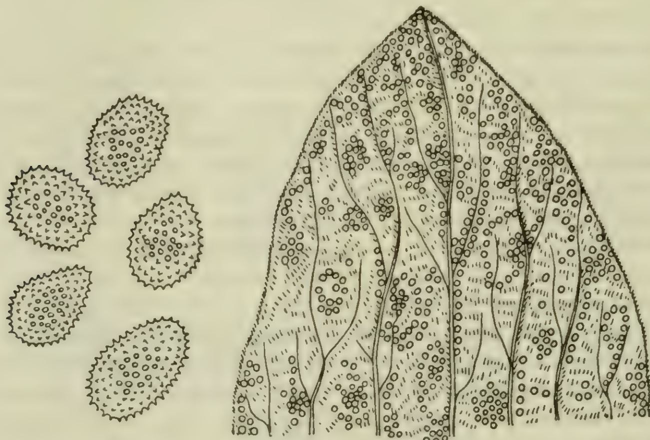
On **Galium triflorum** Michx. — EUROPEAN PART: Lad.-Ilm. (Leningrad Region: Levashevo).

On **Galium aparine** L. -- EUROPEAN PART: U. Dns. (Drogobych Region).

On Compositae

9. **Thekopsora asteris** ("asteridis") Tranz. ex Hirats., Monogr. Pucciniastreae, 1936, p. 328 (uredosporae).

Syn.: **Thekopsora asterum** Tranz. Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 380 (uredio- and teliospores), p. 355.



1 2

FIGURE 62. **Thekopsora asteris** Tranz.:

1 — urediospores on **Aster trinervius** Roxb., × 600; 2 — leaf of **Aster alpinus** L., infected by **T. asteris**, × 5. (Orig.)

247 Spermagonia and aecia unknown.

Uredia hypophyllous, scattered or in groups varying in size, 112 — 280 μ across, orange-colored, covered by hemispherical peridium and epidermis; peridial cells thin-walled, small, elongated only at the very base. Urediospores subgloboid, 15 — 34 × 11.4 — 19 μ (mostly 21 × 15 μ); wall colorless, echinulate; contents orange-yellow (Figure 62).

Telia hypophyllous, inconspicuous, with small brownish spots. Teliospores intracellular, intraepidermal, divided vertically into 2 — 4, rarely 6 or more cells, brown.

The fungus has not yet been found outside the USSR.

On **Aster alpinus** L. — FAR EAST: Dau. (Buryat-Mongol ASSR: Kyakhta (II, III, collection of P. Mikhno, 1915, 1916)).

On **Aster (Calimeris) incisus** Fisch. — FAR EAST: Uss. (Vladivostok area (II, coll. Tranzschel, 1929)).

On **Aster maackii** Regel — ditto (II coll. Tranzschel).

On **Aster amellus** L. — ditto (II).

On **Heteropappus hispidus** Less. — ditto (II).

7. Genus CALYPTOSPORA Jul. Kühn

Jul. Kühn, Hedwigia, VIII, 1869, S. 81.

Spermagonia rudimentary, not producing spermatia, subcuticular, hemispherical, flat at the base.

Aecia with white cylindrical peridia and orange-yellow spores.

Urediospores absent.

Telia on abnormally elongated and thickened stems of the host plant, brown. Teliospores intraepidermal, intracellular, longitudinally septate, brown, germinating after overwintering.

Distinguished from **Thekopsora** by absence of the uredial stage and formation of teliospores on stems thickened along most of their extent.

Only one species is known.

On Vaccinium vitis-idaea L.

1. **Calyptospora goeppertiana** J. Kühn, Hedwigia, VIII, 1869, S. 81; Sacc., Sylloge, VII, 1888, p. 766; Bubák, Ann. mycol. II, 1904, p. 361; Rostpilze Böhmens, 1908, S. 189, Fig. 46; Migula, Kryptog.-Fl. Deutschl. III, 1, 1910, S. 471, Taf. XE, Fig. 1, 2; Grove, Brit. Rust Fungi, 1913, p. 59, 372, fig. 36, 273; Klebahn, Kryptofgl. M. Brandb. Va, 1914, S. 846, Fig. T 1; Syd., Monogr. Ured. III, 1915, p. 470, tab. XX, fig. 163; Fragoso, Fl. Iber. Ured. II, 1925, p. 274; Hunter, Bot. Gaz. LXXXIII, 1927, tab. II, p. 9, fig. 7 (spermagonia); Hirats., Monogr. Pucciniastreae, 1936, p. 329; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 312.

Syn.: **Pucciniastrum goeppertianum** (J. Kühn) Kleb., Wirtswechs. Rostpilze, 1904, S. 391; Fischer, Ured. Schweiz, 1904, S. 466, Fig. 304; Hariot, Uréd., 1908, p. 253, fig. 30; Liro, Ured. Fenn., 1908, p. 518; Trotter, Fl. Ital. Crypt. Ured., 1914, p. 387, fig. 8, 10, 34, 97; Arth., Manual Rusts U. S. a. Canada, 1934, p. 19, fig. 30.

Calyptospora columnaris J. Kühn in Rabenhorst et Winter, Fungi europ. No. 3521, 1886; Hedwigia, XXVI, 1887, S. 28; Arth., N. Amer. Fl. VII, 1907, p. 114; 1925, p. 646, 819.

248 Aecidium columnare Alb. et Schw., Consp. Fung. Nisk., 1805, p. 121.

Thekopsora goeppertiana Hirats., Journ. Soc. Agric. a. Forestr. Sapporo, XIX, 1927, p. 167.

Biol. Hartig, Allg. Forst- u. Jagdzeit., 1880, S. 289; Flora, LXIV, 1881, p. 45; Kühn, Hedwigia, XXIV, 1885, S. 108; XXVI, 1887, S. 28; Bubák, Zentrbl. Bakteriol. II. Abt., XVI, 1906, S. 154; Arth., Mycologia, II, 1910, p. 231; Fraser, Mycologia, IV, 1912, p. 177; VI, 1914, p. 27; Weir, Mycologia, XVIII, 1926, p. 274; Faull, Journ. Arn. Arb. XX, 1939, p. 104.

Spermagonia hypophyllous, small, 42 — 137 μ across, 13 — 30 μ high, on an average 73 × 21 μ, inconspicuous, subcuticular, numerous, flattened, hemispherical or conical with a flat base; spermatophores disposed somewhat radially, the cuticle covering the spermagonia not always erumpent. Spermatia not developing.

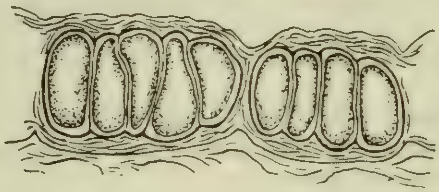


FIGURE 63. Calyptospora goeppertiana J. Kühn on Vaccinium vitis-idaea L. Teliospores, × 600. (Orig.)

Aecia hypophyllous, in 2 rows; peridia cylindrical, up to 2 mm high, white; peridial cells thin-walled, inner wall verruculose. Aeciospores ellipsoid, 16 — 23 × 12 — 16 μ; wall colorless, uniformly very finely verrucose; contents orange.

Teliospores on the elongated, extremely thickened stems, pink, later becoming brown and enveloping the entire stem, intraepidermal, intracellular, densely crowded, ellipsoid or prismatic, longitudinally divided into 4 or more cells, 18 — 36 × 12 — 24 μ; wall thin, dark brown, thickening at the apex up to 3 — 4 μ; each cell with a pore (Figure 63).

Aecia on Abies, teliospores on species of Vaccinium. In the USSR on foxberry only in distribution areas of the fir.

General distribution: Europe, Asia, America.

On Abies sibirica Ledeb. — EUROPEAN PART: V.-Kama (Molotov Region: Kungur); W SIBERIA: Ob (Tara Subregion, Tomsk).

On Abies sachalinensis Mast. — FAR EAST: Sakh. (Sakhalin I., Kuril Is.).

On Vaccinium vitis-idaea L. — EUROPEAN PART: Dv.-Pech. (Arkhangel'sk Region: Yarensk; Komi ASSR: Timan Mts., Usa River, Shchugor River; Vologda Region: Totna District), V.-Kama (Kirov Region: Omutninsk, Malmyzh, Kirov, Kotel'nich, Khalturin; Tatar ASSR: Kazan; Mari ASSR: Ioshkar-Ola; Molotov Region: Okhansk), U. Dns. (Stanislav Region), Urals (Mount Kachkanar, Mount Blagodat); W SIBERIA: Ob

(Tobol'sk, Berezovo; E SIBERIA: Ang.-Say. (Sayans; Chuna-Angara interfluve, Karabulak River; Irkutsk, Balagansk); FAR EAST: Sakh. (Sakhalin I., Kuril Is.).

The connection of aecia on **Abies alba** with the teliospores on foxberry was first established by Hartig (l. c., 1880, 1881), who successfully infected the fir. Later, Kühn (l. c., 1885, 1887) repeatedly infected several species of **Abies** including **Abies sibirica**; Bubák obtained aecia on **Abies alba**. In America, Arthur (l. c., 1910) infected **Abies fraseri** with teliospores from **Vaccinium pennsylvanicum**, while Fraser (l. c., 1912, 1914) infected **Abies**
249 **balsamea** with teliospores from the same source; Faull (l. c., 1939) obtained aecia on **Abies balsamea** from teliospores on **Vaccinium pennsylvanicum** and **V. canadense**. In the western United States, Weir (l. c., 1926) succeeded in infecting **Abies lasiocarpa** with teliospores from **Vaccinium membranaceum**, but the aecia obtained were different from those of **Aecidium columnare** (cp. Faull, l. c., 1939, p. 109).

Mass contamination with the fungus lowers the productivity of red bilberry bushes.

8. Genus MELAMPSORIDIUM Kleb.

Kleb., Ztschr. Pflanzenkr. IX, 1899, S. 21.

Spermagonia subcuticular, flattened convex, devoid of ostiolar filaments.

Aecia projecting, cylindrical or laterally constricted. Aeciospores with colorless walls, verrucose, except for small smooth areas; contents orange-yellow.

Uredia covered with hemispherical peridium; ostiolar cells extending into an acute apex; walls colorless, echinulate; contents orange-yellow.

Telia subepidermal. Teliospores unicellular, with brown walls, germinating after overwintering.

Four species are known, all on representatives of the family **Betulaceae**; aecia on needles of **Larix**. One species ranges in Europe, Asia, North America, and New Zealand; another in southern Europe, Japan, and eastern North America; a third, known in Europe only in Scotland, is also found in the Soviet Far East, in Japan, and apparently in North and South America; the fourth — in the USSR (Siberia) and Japan.

Key to Species of Genus **Melampsoridium**

I. On **Carpinus, Corylus, Ostrya** . . . . 1. **M. carpini** (Nees) Diet.
II. On **Betula** . . . . 2. **M. betulae** (Schum.) Arth.
III. On **Alnus**
  A. Urediospores $21.6-34.2 \times 10.4-18\mu$; walls uniformly echinulate. On species of **Alnus**, section **Gymnothyrsus** . . . . 4. **M. hiratsukanum** Ito.
  B. Urediospores $32.4-46.8 \times 8.8-15.2\mu$, smooth at the apex. On species of **Alnus**, section **Alnobetula** . . . . 3. **M. alni** (Thüm.) Diet.

On Betulaceae

1. **Melampsoridium carpini** (Nees) Diet., in Engler u. Prantl, Nat. Pflanzenfam. I, Abt. 1**, 1900, S. 551; Fischer, Ured. Schweiz, 1904, S. 515, Fig. 321; Klebahn, Ztschr. Pflanzenkr. XVII, 1907, S. 152; Hariot, Uréd., 1908, p. 265; Migula, Kryptog.-Fl. Deutschl. III, 1, 1910, S. 488, Taf. XIB, Fig. 3; Sacc., Sylloge, XXI, 1912, p. 600; Klebahn, Kryptogfl. M. Brandb. Va, 1914, S. 819; Trotter, Fl. Ital. Crypt. Ured., 1914, p. 422; Syd., Monogr. Ured. III, 1915, p. 428; Fragoso, Fl. Iber. Ured. II, 1925, p. 248, fig. 121; Arth., N. Amer. Fl. VII, 1925, p. 680; Manual Rusts U.S. a. Canada, 1934, p. 23, fig. 34; Hirats., Monogr. Pucciniastreae, 1936, p. 192; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 159, 160.

250 Syn.: **Caeoma carpini** Nees, System Pilze, 1816, S. 16.

Uredo carpini Desmaz., Fl. Krypt. No. 674, 1834.

Melampsora carpini Fuckel, Symbol. Mycol., 1870, p. 44; Sacc., Sylloge, VII, 1888, p. 593.

Spermagonia and aecia unknown.

Uredia hypophyllous, scattered or in small groups, on yellow patches, 0.1 — 0.25 mm across, covered by hemispherical peridium; inner wall of peridial cells slightly thickened, 3 — 4 μ; ostiolar cells of peridium thick-walled, extruded into long echinules. Urediospores prismatic, clavate or pyriform, 18 — 28 × 8 — 14 μ; wall colorless, echinulate, smooth at the summit; contents yellow (Figure 64).

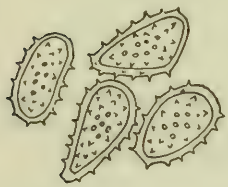


FIGURE 64. **Melampsoridium carpini** (Nees) Diet. on **Carpinus betulus** L. Urediospores, × 600. (Orig.)

Telia hypophyllous, subepidermal, scattered, minute, yellowish-brown. Teliospores prismatic or clavate, 28 — 50 × 8 — 16 μ; wall light yellowish-brown, smooth.

On species of **Carpinus**.

General distribution: Europe, Asia (Japan), North America.

Teliospores develop rarely. In Japan on **Carpinus yedoensis** Max., **C. laxiflora** Bl. and **C. cordata** Bl.; on the latter, also in the USSR (Far East). In North America, in New York State on **Ostrya virginiana** K. Koch. In the USSR the species is known only in the uredial stage.

On **Carpinus betulus** L. — EUROPEAN PART: U. Dns. (Berezhan area (according to Bovyak, 1907)); CAUCASUS: W Transc. (Sochi, Sukhumi, Tsebel'da, Gagra), E Transc. (Georgian SSR: Lagodekhi).

On **Carpinus orientalis** Mill. — CAUCASUS: W Transc. (Abkhaz ASSR: Azara (collected by Siemaszko)).

On **Corylus avellana** L. (?) — in Abkhazia, on Mount Abardra, Siemaszko collected in September 1914 uredia from **Carpinus betulus** and at the same time from **Corylus avellana** L., and assumed that the fungus on the latter was **Pucciniastrum coryli**, but the presence of echinulate peridial cells in the specimens examined by us convinced us that they should be referred to **Melampsoridium**.

Pathogenicity of the species unknown.

2. **Melampsoridium betulae** (Schum.) Arth., N. Amer. Fl. VII, 1907, p. 110; 1925, p. 680; 1927, p. 818; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 159, 160.

Syn.: **Melampsoridium betulinum** (Pers.) Kleb., Ztschr. Pflanzenkr. IX, 1899, S. 21, Fig. 1; Jahrb. wiss. Bot. XXXIV, 1900, S. 387; Jahrb. Hamburg. wiss. Anst. (1902) 1903, S. 30; Wirtswechs. Rostpilze, 1904, S. 401; Kryptogfl. M. Brandb. Va, 1914, S. 816, 902, Fig. P1; Fischer, Ured. Schweiz, 1904, S. 512, Fig. 320; Sacc., Sylloge, XVII, 1905, p. 464; Liro, Acta Soc. fauna et flora Fenn. XXIX, 6, 1906, p. 18—19; Bubák, Rostpilze Böhmens, 1908, S. 210, Fig. 58; Hariot, Uréd., 1908, p. 264; Migula, Kryptog.-Fl. Deutschl. III, 1, 1910, S. 487, Taf. XIB, Fig. 1, 2; Grove, Brit. Rust Fungi, 1913, p. 358, fig. 267, 268; Trotter, Fl. Ital. Crypt. Ured., 1914, p. 421, fig. 108; Syd., Monogr. Ured. III, 1915, p. 425; Fragoso, Fl. Iber. Ured. II, 1925, p. 246, fig. 119, 120; et Arth., Manual Rusts U.S. a. Canada, 1934, p. 22, fig. 32; Hirats., Monogr. Pucciniastreae, 1936,
251 p. 185, tab. VII, fig. 5.

Melampsora betulina Desmaz., Pl. Crypt. France, No. 2047, 1850; Liro, Acta Soc. fauna et flora Fenn. XXIX, 7, 1907, p. 1—9; Ured. Fenn., 1908, p. 522.

Uredo populina β **Uredo betulina** Pers., Synops. fung. 1801, p. 219.

Uredo betulae Schum., Enum. plant. Saelland, II, 1803, p. 228.

Biol. Plowright, Ztschr. Pflanzenkr. I, 1891, S. 130; Bull. Soc. mycol. France, XVII, 1901, p. 98; Klebahn, Jahrb. wiss. Bot. XXXIV, 1900, S. 387; Jahrb. Hamburg. wiss. Anst. (1902) 1903, S. 30; Wirtswechs. Rostpilze, 1904, S. 401; Liro, Acta Soc. fauna et flora Fenn. XXIX, 6, 1906, p. 18, 19; 7, 1907, p. 9—21; Ured. Fenn., 1908, p. 459; Vanin, Lesn. fitopatol., 1948, p. 112.

Spermagonia amphigenous, scattered, inconspicuous, pale yellow, subcuticular, 100—150 μ across, 50—65 μ high.

Aecia hypophyllous; peridium vesicular, laterally constricted, 0.5—1.25 mm long, 0.25 mm wide, flattened, 0.5 mm, white; outer wall of peridial cells 1 μ thick, almost smooth, shagreen, inner wall up to 3—4 μ thick, verrucose. Aeciospores globoid, or broad-ellipsoid, 14—21 × 11—16 μ; wall colorless, finely verrucose with a smooth spot on one side; contents orange-yellow.

Uredia hypophyllous, on yellow patches, scattered or in groups, covered by hemispherical peridium, up to 5 mm across; inner walls of peridial cells thickened, 4—8 μ; ostiolar cells of peridium tapering into elongate echinules, up to 35 μ long. Urediospores elongate, occasionally clavate, 22—40 × 8—22 μ; walls colorless, sparingly echinulate, smooth at the apex; contents orange-yellow.

Telia hypophyllous, subepidermal, minute, at times confluent, at first reddish-brown, later brown. Teliospores prismatic, 30—50 × 7—15 μ; walls thin, scarcely thickened at apex, pale brown to almost colorless; pores inconspicuous (Figure 65).

Aecia on species of **Larix**, uredio- and teliospores on species of **Betula**.

General distribution: Europe, Asia, North America. Found in New Zealand.

The fungus may grow in places remote from **Larix**, as it apparently overwinters by the mycelium in birch seedlings; very extensive area of distribution.

On **Larix sibirica** Ledeb. — EUROPEAN PART: Lad.-Ilm. (Leningrad Region: Staryi Petergof), U. V. (Gzhatsk; Moscow Region).

On **Larix decidua** Mill. — EUROPEAN PART: Balt. (Latvian SSR).

On **Betula ermani** Cham.— FAR EAST: Kamch.

On **Betula ermani** Cham. var. **genuina** Winkl. — FAR EAST: Sakh. (S Sakhalin).

252 On **Betula nana** L. — EUROPEAN PART: Kar.-Lap. (Murmansk Region; Karelian ASSR), Dv.-Pech. (Arkhangel'sk Region), Lad.-Ilm. (Leningrad Region); W SIBERIA: Ob (Tara, basin of Severnaya [Northern] Sosva River).

On **Betula exilis** Sukacz. — W SIBERIA: Ob (Eniseisk, Murino).

On **Betula middendorfii** Trautv. et Mey — FAR EAST: Sakh. (S Sakhalin).

On **Betula humilis** Schrank. — EUROPEAN PART: Dv.-Pech. (Arkhangel'sk Region: Kargopol', Arkhangel'sk cemetery on the Onega River, Vel'sk), Lad.-Ilm. (Kalinin Region: Berezaika station, Lake Limandra, former Borovichi County), Balt., (Estonian SSR, Lithuanian SSR), U. V. (Moscow), V.-Kama (Molotov Region: Il'inskoe village), U. Dnp. (Nevel', Orsha, Vitebsk), V.-Don (Voronezh Region: Zemlyansk District (on **Betula humilis** var. **cretacea**)); W SIBERIA: Ob (Eniseisk), Alt. (Altai); E SIBERIA: Lena-Kol. (Irkutsk Region: Ilım River), Ang.-Say. (Minusinsk).

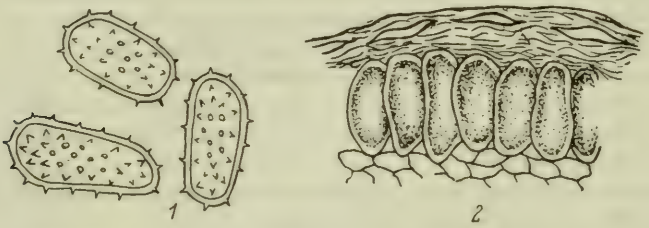


FIGURE 65. **Melampsoridium betulae** (Schum.) Arth. on **Betula pubescens** Ehrh.:

1 — urediospores; 2 — teliospores, × 600. (Orig.)

On **Betula mandshurica** (Reg.) Makai (= **B. japonica** auct. pr. p.) — FAR EAST: Uss. (Maritime Territory: Okeanskaya station, Krivoi Klyuch in the Suifun District).

On **Betula japonica** Sieb. — FAR EAST: Kamch., Sakh. (S Sakhalin).

On **Betula verrucosa** Ehrh. — EUROPEAN PART: Kar.-Lap. (Karelian ASSR), Lad.-Ilm. (Leningrad Region), Balt. (Estonian SSR, Lithuanian SSR), U. V. (Kalinin, Moscow, and Ivanovo regions), V.-Kama (Gorkii Region, Kirov Region, Tatar ASSR; Molotov, Krasnoufimsk), U. Dnp. (Smolensk Region, Belorussian SSR; Ukrainian SSR; Chernigov Region (Priluki)) M. Dnp. (Kursk Region), V.-Don (Voronezh, Tambov, and Kharkov regions), Urals (Verkhotur'e); CAUCASUS: Cisc., W Transc. (Abkhaz ASSR), E Transc. (Georgian SSR: Bakuriani); W SIBERIA: Ob (Tomsk), Irt. and Alt. (Altai); E SIBERIA: Ang.-Say. (Minusinsk, Irkutsk Region).

On **Betula platyphylla** Sukacz.— FAR EAST: Kamch.

On **Betula alba** auct. — EUROPEAN PART: U. Dns. (Berezhan area (according to Bovyak, 1907)).

On **Betula kusmisšcheffii** (Regel) Sukacz. — EUROPEAN PART: Kar.-Lap. (Murmansk Region: Iokanga, Khibiny Mts.).

On **Betula pubescens** Ehrh. — EUROPEAN PART: Kar.-Lap. (Murmansk Region: Khibiny Mts.; Karelian ASSR), Dv.-Pech. (Arkhangel'sk Region: Kargopol', Onega River; Komi ASSR: Shchugor River), Lad.-Ilm.

(Leningrad Region), Balt. (Estonian SSR, Latvian SSR, Lithuanian SSR), U. V. (Kalinin, Moscow, Ivanovo, and Yaroslavl' regions), V.-Kama (Kirov Region, Molotov Region, Tatar ASSR), U. Dnp. (Smolensk and Chernigov regions), U. Dns. (Lvov Region), M. Dnp. (Ternopol' Region), V.-Don (Voronezh, Tula, and Kharkov regions); CAUCASUS: Cisc. (Voroshilovsk, Kislovodsk), W Transc. (Georgian SSR: Kutaisi), E Transc. (Georgian SSR: Bakuriani; Azerbaijan SSR: Zakataly); W SIBERIA: Ob (Tobol'sk, Novosibirsk), Irt., Alt. (Altai); E SIBERIA: Ang.-Say. (Irkutsk Region).

On **Betula turkestanica** Litv. (?) — CENTRAL ASIA: Tien Shan (Alma-Ata).

The connection of **Melampsoridium betulae** with the aecial stage on **Larix** was first established by Plowright (l. c., 1891, 1901), who considered the aecium a caeoma. Klebahn (1900, 1903, 1904) repeated the infection of larch and described the aecia; Liro (1906, 1907, 1908) could not infect the
253 larch and proved that the fungus overwinters on birch seedlings. According to Plowright and Klebahn the fungus scarcely passes from **Betula pubescens** to **B. verrucosa** and vice versa. Pathogenicity of the fungus unknown. In years of excessive dissemination the fungus causes premature yellowing and drying up of birch foliage. In infected leaves the amount of chlorophyll is reduced by 30—40%.

3. **Melampsoridium alni** (Thüm.) Diet. in Engler u. Prantl, Nat. Pflanzenfam. I, Abt. 1**, 1900, S. 551; Syd., Monogr. Ured. III, 1915, p. 430, pr. p.; Arth., N. Amer. Fl. VII, 1925, p. 630, pr. p.; Hirats., Monogr. Pucciniastreae, 1936, p. 181; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 160.

Syn.: **Melampsora alni** Thüm., Bull. Soc. nat. Moscou, LIII, 1878, p. 226; Sacc., Sylloge, VII, 1888, p. 595; Tranzschel, Zap. Bot. sada SPb. univ. III, 1891, p. 139; IV, 1895, p. 301.

Peridermium krylovianum Lavrov, Izv. Tomsk. univ. LXXVI, 2, 1926, p. 169.

Biol. Hiratsuka, Japan. Journ. Bot. VI, 1932, p. 16.

Spermagonia mainly hypophyllous, subcuticular, minute, lenticular, $90-126 \times 30-55\mu$, honey-colored. Spermatia oblong, $6.2-9.0 \times 2.4-4.2\mu$.

Aecia hypophyllous, cylindrical, 0.5—2.0 mm across, up to 1.4 mm high; peridial cells colorless, their inner walls thick, densely verrucose. Aeciospores ellipsoid, $19-26 \times 15-20\mu$; walls verruculose, $1.8-2.5\mu$ thick, with smooth patches on some spores; contents orange-yellow.

Uredia hypophyllous, scattered or in groups on yellow or reddish spots, small, 0.12—0.4 mm across, reddish-yellow, covered by hemispherical peridia consisting of small angular cells; ostiolar cells extruded into an acute conical apex, $21.6-32.4\mu$ long. Urediospores obclavate or linearly oblong, $32.4-46.8 \times 8.8-15.2\mu$; walls colorless, echinulate, rather thin, thinnest and smoothest at the summit; paraphyses(?) rudimentary.

Telia hypophyllous, small, scattered or in groups, 0.3—0.5 mm across, purple or black-brown. Teliospores subepidermal, $32.4-46.8 \times 12.6-18\mu$; walls light yellowish-brown, rather thin, smooth (according to Hiratsuka) (Figure 66).

Aecia on **Larix**. Uredio- and teliospores on species of **Alnus**, section **Alnobetula**, in Siberia and Japan.

General distribution: USSR (Siberia, Far East), Japan.

On **Larix sibirica** Ledeb. — W SIBERIA: Ob (Krasnoyarsk Territory: Yenisei River, Plakhina station, Katanga at the mouth of the Turami River).

On **Alnus fruticosa** Rupr. — W SIBERIA: Ob (Omsk Region: the Malaya [Lesser] Sosva River and the Severnaya Sosva River; Tomsk; near Eniseisk and near Krasnoyarsk), Alt. (Lake Teletskoe); E SIBERIA: Ang.-Say. (Mount Borus in the Sayans); FAR EAST: Sakh. (Sakhalin I.).

On **Alnus maximowiczii** Call. (= **A. alnobetula** Hartig var. **sachalinensis** Koidz.) — FAR EAST: Sakh. (S Sakhalin).

Hiratsuka (Journ. Facult. Agric. Hokkaido Univ. XXI, 1927) distinguished from **Melampsoridium alni** (on **A. maximowiczii** Call.) two species growing in Japan: **M. alni-pendulae** Hirats. (l. c., p. 8), and **M. alni-firmae** Hirats. (l. c., p. 9), but united them again in 1932, under the designation **M. alni**.

254 Hiratsuka (l. c., 1932) infected with teliospores produced on **Alnus maximowiczii** three species of **Larix**; with the aeciospores thus obtained he succeeded in infecting **A. maximowiczii** but not **A. hirsuta**. Aecia on **Larix kaempferi** were also produced following infection with teliospores from **Alnus pendula**.

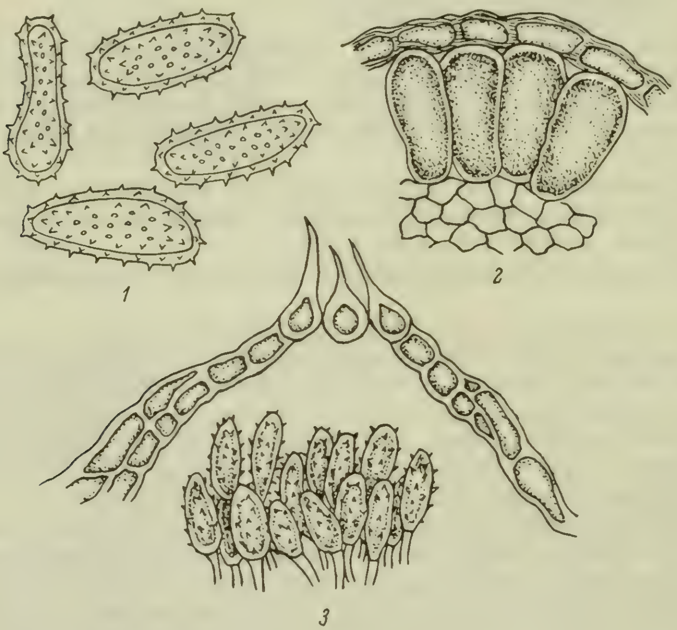


FIGURE 66. Melampsoridium alni (Thüm.) Diet. on Alnus:

1 — urediospores; 2 — teliospores; 3 — cells surrounding peridial ostiole extruded in acute echinules, × 600. (Orig.)

4. **Melampsoridium hiratsukanum** Ito ex Hiratsuka, Journ. Facult. Agric. Hokkaido Univ. (Sapporo), XXI, 1927, p. 9; Hirats., Japan. Journ. Botany, VI, 1932, p. 19—21; Monogr. Pucciniastreae, 1936, p. 194; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 160.

Syn.: **Melampsoridium alni** (non Diet.); Syd., Monogr. Ured. III, 1915, p. 430, pr. p., tab. XVIII, fig. 158; Wilson, Trans. Brit. Mycol. Soc. IX, 1924, p. 140; Trans. Bot. Soc. Edinb. XXXI, 1934, p. 425; Arth., N. Amer. Fl. VII, 1925, p. 680, pr. p.; Manual Rusts U. S. a. Canada, 1934, p. 23, fig. 33.

Biol. Hiratsuka, l. c., 1936.

Spermagonia and aecia as in **Melampsoridium alni**.

Uredia hypophyllous, scattered or in groups producing reddish-brown spots on the upper side of leaves, small, 0.2 — 0.4 mm across, orange-yellow, covered by hemispherical peridia consisting of minute angular cells;
255 ostiolar cells larger, 32.4 — 55.8 μ long, extending into elongate sharp echinules. Urediospores globoid, subgloboid, ovoid, or ellipsoid, 21.6 — 34.2 $\times$ 10.4 — 15.2 μ; walls colorless, sparsely echinulate over entire surface; conspicuous rudimentary fusiform paraphyses (according to Hiratsuka) (Figure 67).

Telia hypophyllous, subepidermal, scattered or in groups, yellow, later dark brown. Teliospores prismatic, light brown, 32.4 — 43.0 $\times$ 10.8 — 16.2 μ; walls, about 1 μ thick. Distinguished from the closely related **M. alni** by larger urediospores.

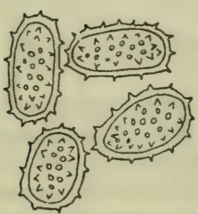


FIGURE 67. **Melampsoridium Hiratsukanum** Ito on **Alnus japonica** Sieb. et Zucc. Urediospores, × 600. (Orig.)

On species of **Alnus** of section **Gymnothyrsus**, aecia on **Larix**. In the Soviet Far East and in Japan.

On **Alnus hirsuta** Turcz. (= **A. incana** var. **hirsuta** Spach) — FAR EAST: Ze.-Bu. (Amur Region, Bureya Mts., Sutar River valley at the Lyubavinskii mine), Uss. (Maritime Territory: near Shkotovo and along the Mongugai River, Pos'et District), Sakh. (S Sakhalin).

On **Alnus japonica** Sieb. et Zucc. — FAR EAST: Maritime Territory, near Shkotovo. — In same locality on hybrids of the two species (**A. hirsuta** $\times$ **A. japonica**). Apparently, the same fungus is found also in Scotland on **Alnus incana** Willd. and **A. glutinosa** Gaertn., as well as on species of **Alnus** in North and Central America, from California to Guatemala, and in South America in Equador.

Aecia were obtained in culture on **Larix**. In the opposite direction infections were produced in **Alnus hirsuta** and **A. hirsuta** var. sibirica; **A. fruticosa** was not infected (Hiratsuka, 1936, p. 198).

II. Subfamily CRONARTIEAE

Uredia covered by peridia or surrounded by paraphyses. Urediospores not in chains. Teliospores develop in series, united into a cylindrical column or in a flattened lenticular sorus. Species of **Cronartium** form aecia on stems and branches of pines (species of genus **Pinus**). The cycle of development of genus **Phakopsora** has not been clarified.

Key to Genera of Subfamily **Cronartieae**

I. Teliospores in lenticular heaps with brown walls . . . . 9. **Phakopsora** Diet.

II. Teliospores in cylindrical columns with colorless walls . . . . 10. **Cronartium** Fries.

9. Genus PHAKOPSORA Diet.

Diet., Ber. Deutsch. bot. Ges. XII, 1895, S. 333; Syd., Monogr. Ured. III, 1915, p. 407; Hirats., Phakopsora of Japan, Bot. Mag. XLIX, 1935, p. 781—789, 853—860; L, 1936, p. 1—8.

Spermagonia and aecia unknown.

Uredia of typical species covered by hemispherical peridia which open at the apex through round aperture, in other species surrounded by a dense crown of paraphyses. Urediospores formed singly on short pedicels, without conspicuous pores, accompanied by clavate paraphyses, frequently adnate at their bases.

Telia small, dark brown, subepidermal, consisting of several rows of spores.

256 The genus **Phakopsora** consists of 30 species, of which 12 occur in southern and eastern Asia. They are unknown in the USSR, but they might penetrate into the Far East. The life history of none of the species is so far known. The position of this genus in the system of rust fungi is not final, since nothing is known about the structure of their spermagonia and aecia, nor about their hosts. Species with peridia, resembling those of **Pucciniastreae**, species with paraphyses (**Physopella** Arth.), should probably be separated from the family **Melampsoraceae**.

Six species found in zones adjacent to the USSR are described below.

Key to Species of **Phakopsora**

I. Uredia smooth . . . . 2. **P. compositarum** J. Miyake.

II. Uredia echinulate.

- A. Uredia covered with peridium of thin cells . . . . 1. **P. punctiformis** (Barcl. et Diet.) Diet.
- B. Uredia surrounded by paraphyses, adnate at the base, resembling peridia.
  1. On **Glycine soja** . . . . 4. **P. sojae** (P. Henn.) Sawada.
  2. On **Zizyphus** and **Paliurus** . . . 6. **P. zizyphi-vulgaris** Diet.
- C. Uredia surrounded by paraphyses, not attached at the base, straight or flexed inward.
  1. On **Vitaceae** (**Ampelopsis**, **Vitis**, etc.) . . . . 5. **P. vitis** (Thüm.) Syd.
  2. On **Compositae** (**Artemisia**, **Aster**, etc.) . . . . 3. **P. artemisiae-japonicae** (Diet.) Tranz.

On **Rubiaceae**

1. **Phakopsora punctiformis** (Barcl. et Diet.) Diet., Ber. Deutsch. bot. Ges. XIII, 1895, S. 333; Syd., Monogr. Ured. III, 1915, p. 408, tab. XVI, fig. 151, 152.

Uredia amphigenous, minute, about 0.1 — 0.15 mm across, yellowish-brown, covered with a thin peridium of small cells. Urediospores ellipsoid or elongate-pyriform, 22 — 32 × 16 — 21 μ; walls thin, echinulate. Among the spores are clavate or clavate-bulbous paraphyses, up to 30 μ across.

Telia hypophyllous, scattered, minute, 0.1 — 0.15 mm across, brown. Teliospores in 2 — 5 layers, oblong, 25 — 50 × 14 — 20 μ; walls yellowish-brown, smooth, the upper spores greatly thickened at the apex (up to 11 μ) and darker (Figure 68).

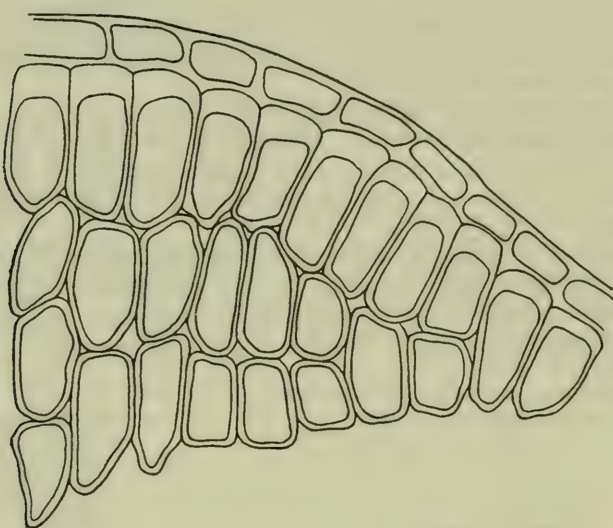


FIGURE 68. **Phakopsora punctiformis** (Barcl. et Diet.) Diet. on **Galium aparine** L. Teliospores (after Sydow)

On leaves of **Galium aparine**, near Simla in India. Uredia distinguished from those of **Thekopsora galii** (Magnus, Ber. Deutsch. bot. Ges., XIV, 1896, S. 130. Taf. IX, Fig. 6, 7) by the absence of elongate cells at the lower part of peridium and the presence of paraphyses. We have not seen specimens of this fungus, which was apparently found only once.

On **Compositae**

2. **Phakopsora compositarum** J. Miyake, Bot. Mag. Tokyo, XXVII, 1913, p. 43, fig.

Uredia hypophyllous, rarely caulicolous, minute, reddish-brown; peridia and paraphyses not mentioned. Urediospores 24 — 28 × 14 — 18 μ; yellowish; walls smooth.

257 Telia black, scattered, punctate, slightly convex, subepidermal. Teliospores in 4—6 layers, $24-60 \times 14-18\mu$, considerably thickened above, dark, smooth, with pores.

On **Aster** sp. and **Artemisia** sp. near Peking in China. We have not seen the specimens.

3. **Phakopsora artemisiae-japonicae** (Diet.) Tranz., Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 380.

Syn.: Uredo **artemisiae-japonicae** Diet. in Engler's Bot. Jahrb. XXXIV, 1905, S. 591; XXXVII, 1905, S. 108; Syd., Monogr. Ured. IV, 1924, p. 386.

Phakopsora artemisiae Hirats., Japan. Journ. Bot. III, 1927, p. 298.

Uredia amphigenous, mostly epiphyllous, scattered or in irregular groups, very small, covered for a long time by the epidermis, later opening through a central orifice, or irregularly, without peridia; paraphyses clavate or bulbous, irregular, straight or flexed inward, colorless or almost colorless, $38.0-41.9\mu$ long. Urediospores ovoid or ellipsoid, pale yellowish, $23.4-38.0 \times 16.2-25.2\mu$; walls colorless, 1.5μ thick, echinulate (short spikes) with inconspicuous pores (Figure 69).

Telia mostly hypophyllous, minute, 0.1—0.5 mm across, yellowish-brown at first, dark brown when mature, covered by the epidermis. Teliospores lenticular, in 3—5 layers, prismatic or cubical, yellow to dark brown, $19.4-32.4 \times 14.4-18.0\mu$; walls $1-2\mu$ thick, the upper spores thickened above, $2-3\mu$.

On species of **Artemisia**, **Aster**, on **Chrysanthemum eupatorium** in S Japan, and on **Artemisia vulgaris** L. var. **kamtschatica** Bess. (= var. **yezoana** Kudo — uredio- and teliospores) in Hokkaido Island (Japan). This species is probably identical with the preceding species.

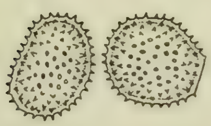


FIGURE 69. **Phakopsora artemisiae-japonicae** (Diet.) Tranz. on **Artemisia vulgaris** L. Urediospores, × 600. (Orig.)

FIGURE 70. **Phakopsora sojae** (P. Henn.) Sawada on **Glycine hispida** Maxim. Urediospores, × 600. (Orig.)

258 On **Leguminosae**

4. **Phakopsora sojae** (P. Henn.) Sawada, Descript. Catal. Formosa Fungi, VI in Rept. Dept. Agric. Res. Inst. Formosa, XXI, 1933 (non vidi). Ref.: Review Appl. Mycol. XIII, 1934, p. 398.

Syn.: **Uredo sojae** P. Henn. in Hedwigia, XLII, 1903, S. (108); Sacc., Sylloge, XVII, p. 446.

Uromyces sojae Syd., Monogr. Ured. II, 1910, p. 128 (pr. p. quoad uredosporas, teleutosporis exclusis).

Uredia hypophyllous, scattered or in small groups, small, covered by the epidermis, later opening through a central orifice; paraphyses numerous, fused at their brown bases, resembling peridia, above colorless and bulging, slightly club-shaped. Urediospores ovoid or ellipsoid, $18-33 \times 14.5-20.4\mu$; walls turning brown, 1μ thick, echinulate, with inconspicuous pores (Figure 70).

Sawada's description of the spores (l. c.) was inaccessible to us.

On soy (**Glycine soja** (L.) Benth.) in Japan and in Java; Manchuria is listed as another habitat.

Sydow and Butler (Ann. myc. IV, 1916, p. 429) have described the teliospores under the designation **Uromyces sojae** (P. Henn.) Sydow, on the basis of specimens collected by Butler in India, and published in "Sydow, Uredineen, No. 2109." However, in the work published by Butler and Bisby, "The Fungi of India" (1931, p. 84), it is indicated that the fungus on soy is not known in India, while the aforementioned specimens are referred to **Uromyces mucunae** Rabh. on **Mucuna**.

Hiratsuka (Trans. Biol. Soc. Tottori, I, 1932, p. 8; Bot. Mag., XLIX, 1935, p. 785) united the fungus on soy with the fungi on other genera of **Leguminosae-Phaseoleae** found in Japan, Java, the Philippines, and the West Indies, under the designation **Phakopsora pachyrhizi** Sydow.

Arthur (N. Amer. Fl. VII, 1925, p. 673) also unites these fungi under the designation **Phakopsora vignae** (Bres.) Arthur (1917), in conformity with the
259 earlier synonym, **Uredo vignae** Bres. (1891). The author is probably right and the species should be named as suggested by Arthur, but since in the USSR the fungus is known only on soy plants we have adopted the designation **P. sojae**.

On Vitaceae

5. **Phakopsora vitis** (Thüm.) Syd., Hedwigia, XXXVIII, 1899, S. (141); Sacc., Sylloge, XVI, 1902, p. 271; Syd., Monogr. Ured. III, 1915, p. 410; Arth., N. Amer. Fl. VII, 1925, p. 673.

Syn.: **Uredo vitis** Thüm., Pilze Weinst., 1878, S. 182, Taf. V, Fig. 10; Sacc., Sylloge, VII, 1888, p. 863.

Physopella vitis (Thüm.) Arth., Résult. scient. Congr. bot. Vienne, 1905, 1906, p. 338; N. Amer. Fl. VII, 1907, p. 102; 1927, p. 817; Manual Rusts U. S. a. Canada, 1934, p. 60.

Phakopsora ampelopsidis Diet. et Syd. apud Diet., Hedwigia, XXXVII, 1898, S. 217; Sacc., Sylloge, 1899, p. 289, Hirats., Bot. Mag. XIV, 1900, p. 89, tab. III, fig. 1—9; Syd., Monogr. Ured. III, 1915, p. 412, tab. XVII, fig. 153.

Uredia hypophyllous, scattered, minute, about 0.1 mm across, emerging early from under the epidermis, pale yellow, surrounded by numerous paraphyses; inward flexed, thin-walled or thickened above. Urediospores ovoid or ellipsoid, $18-28 \times 12-18\mu$; walls thin, almost colorless, finely and rather densely echinulate with inconspicuous pores (Figure 71).

Telia hypophyllous, scattered, minute, 0.1 — 0.2 mm across, covered by epidermis. Teliospores in 3 — 4 layers, ovoid, prismatic or cubical, 18 — 30 × 12 — 15 μ; walls smooth, browish, thin-walled at the apex, occasionally very slightly thickened.

On **Vitis vinifera** L. in southwestern states of North America, the Antilles, South America (only in uredial stage), and in Japan; on **Vitis lanata** Roxb., in Java; on **V. flexuosa** Thunb. and **V. coignetii** Pull. (= **V. amurensis** Rupr. var. **Coignetii** Nakai) in Japan; on **V. tiliifolia** H. et B. (= **V. caribaea** DC.), in Florida and Guatemala; on **V. munsoniana** Simps. (uredia) in Florida; on **Quinaria (Parthenocissus) tricuspidata** (S. et Z.) Koehne, **Parthenocissus thunbergii** Nakai (= **Vitis inconstans** Miq.), **Cissus yoshimurai** Mak., and on **Ampelopsis heterophylla** S. et Z. in Japan.

In the USSR the fungus is unknown but might be imported in the southern Far East or drift in. The cycle of development is still unknown and the synonymy of the species not yet clarified. In the Himalayas, in India, a close species is found on **Quinaria (Parthenocissus) himalayana** (Royle) Gilg with slightly larger urediospores (25 — 36 × 15 — 22 μ) — **Phakopsora cronartiiformis** (Barcl.) Diet.

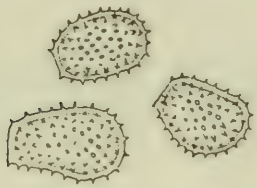


FIGURE 71. Phakopsora vitis (Thüm.) Syd. on Vitis inconstans Miq. Urediospores, × 600. (Orig.)

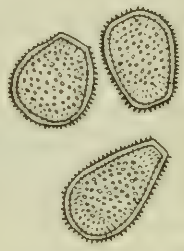


FIGURE 72. Phakopsora zizyphi-vulgaris Diet. on Zizyphus sp. Urediospores, × 600. (Orig.)

On **Rhamnaceae**

6. **Phakopsora zizyphi-vulgaris** Diet., Ann. mycol. VIII, 1910, p. 469; Sacc., Sylloge, XXI, 1912, p. 608; Syd., Monogr. Ured. III, 1915, p. 413.

Syn.: **Uredo zizyphi-vulgaris** P. Henn., Hedwigia, XLI, 1902, S. 21; Sacc., Sylloge, XVII, 1905, p. 444.

260 Uredia hypophyllous, scattered, minute, irregular, 0.1 — 0.3 mm long, covered for a long time by the epidermis, yellowish-brown; paraphyses few, colorless, 30 — 40 μ long, 5 — 8 μ thick. Urediospores ellipsoid or ovoid, densely and short echinulate, pale yellow, 17 — 25 × 12 — 17 μ, walls about 1 μ thick (Figure 72).

Telia hypophyllous, scattered or gregarious, round, minute, 0.1 — 0.25 mm in diameter, black-brown. Teliospores in 2 — 4 layers, oblong or polyhedral with many facets, smooth, yellow-brown, 10 — 18 × 6 — 10 μ; walls 1.0 — 1.5 μ thick.

On species of Zizyphus and Paliurus ramosissimus Poir.

General distribution: Manchuria, Japan, northern China, eastern India.

Possible occurrence in mountainous areas of the Tadzhik SSR.

10. Genus CRONARTIUM Fries

Fries, Observ. mycol. I, 1815, p. 220.

Spermagonia flat, occupying considerable areas under the peridermis, without paraphyses. Spermatia escape through cracks in the bark.

Aecia large, with vesicular peridia, rupturing irregularly at the top, at the sides, or at the base; peridia formed by 2 layers of cells. Spores in chains; walls rather thick, with a homogenous inner layer, and an outer layer containing rods which impart a verrucose appearance from outside, but apart from the spores the wall is more or less smooth.

Uredia covered by hemispherical peridia with apical ostioles. Urediospores single, pedicellate, with sparsely echinulate walls, without perceptible pores.

Telia columnar, rising above the leaf surface; column consisting of densely fused single-celled teliospores often arising from the center of uredia. Teliospores develop in rows; rows and single spores in the rows are firmly joined; soon after their formation at the end of summer each spore germinates into a 4-celled basidium.

Basidiospores globoid.

Spermagonia and aecia elicit the formation on pine stem and branches of swellings varying in extent, occasionally fusiform or spherical. Uredio- and teliospores on various dicotyledonous plants.

Approximately 20 species known in Europe, Asia, and America. In the USSR 6 species.

In the uredio- and teliospore stage differentiation of species is difficult; they are better distinguished in the aecial stage.

Key to Species of Cronartium

I. Aecia on species of Pinus of subgenus Haploxylon Koehne (five-needled fascicles).
   - A. Uredio- and teliospores on species of Ribes . . . . 7. C. ribicola Dietr.
   - B. Uredio- and teliospores on species of Pedicularis, Castilleja (E Asia) . . . . 4. C. kamtschaticum Jørst.

261 II. Aecia on species of Pinus of subgenus Diploxylon Koehne (two-leaved fascicles).
   - A. Heteroecious species.
     1. On Cynanchum, Paeonia, Pedicularis, and other plants (Europe, Asia) . . . . 1. C. flaccidum (Alb. et Schw.) Winter
     2. On Castilleja, Pedicularis (North America) . . . . 5. C. coleosporioides (D. et H.) Arth.
     3. On Quercus . . . . 6. C. quercus (Brond.) Arth.

4. On Gentiana. . . . . 3. **C. gentianeum** Thüm.

B. The fungus develops only aecia . . . . 2. **Peridermium pini** (Willd.) Kleb.

On **Cynanchum, Paeonia, Pedicularis**

1. **Cronartium flaccidum** (Alb. et Schw.) Winter in Rabenhorst's Kryptog.-Fl. I, 1881 S. 236; Sacc., Sylloge, VII, 1888, p. 598; Liro, Ured. Fenn., 1908, p. 449; Syd., Monogr. Ured. III, 1915, p. 560; Fragoso, Fl. Iber. Ured. II, 1925, p. 303, fig. 146; Arth., Manual Rusts U. S. a. Canada, 1934, p. 30; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 40, 55, 56, 70, 73, 193, 262, 321, 337.

Syn.: **Cronartium asclepiadeum** (Willd.) Fries, Observ. mycol. I, 1815, p. 220; Fischer, Ured. Schweiz, 1904, S. 431, Fig. 295; Hariot, Uréd., 1908, p. 279, fig. 42—44; Migula, Kryptog.-Fl. Deutschl. III, 1, 1910, S. 458, Taf. IX J, F ig. 3; Taf. IX K, Fig. 1—3; Grove, Brit. Rust Fungi, 1913, p. 313, fig. 238; Klebahn, Kryptogfl. M. Brandb. Va, 1914, S. 723, Fig. L2 (S. 722); Trotter, Fl. Ital. Crypt. Ured., 1914, p. 362, fig. 24, 88.

Sphaeria flaccida Alb. et Schw., Consp. fung. Nisk., 1805, p. 31.

Erineum asclepiadeum Willd. in Funck, Cryptogam. Gewächse Fichtelgebirges, I, No. 145, 1806.

Aecidium asclepiadeum Wallr., Fl. Crypt. Germ. II, 1833, p. 259 (ex Sydow, l. c.).

Cronartium balsaminae Niessl, Verhandl. Naturf. Ver. Brünn, X, 1872, S. 166.

Cronartium hystrix, C. ruelliae, C. verbenes Dietr., Arch. Naturk. Liv-, Ehst- u. Kurlands, 2, Ser. 1, 5. Lief., 1895, S. 495.

Cronartium nemesiae Vestergren, Bih. Svensk Vet. Akad. Handl. XXII, Afd. III, 6, 1896, p. 5.

Cronartium tropaeoli Palm. Vestergren, Micromyc. rar. sel., No. 1456.

Cronartium pedicularis Lindr., Bot. Notiser, 1900, p. 246; Liro, Ured. Fenn., 1908, p. 441; Hariot, Uréd., 1908, p. 281.

? **Cronartium euphrasiae** Ranoievitch, Ann. Univ. Grenoble, liv. 3, 1918, p. 303 (non vidi); Bull. Soc. mycol. France, XXXV, 1919, p. 18; Sacc., Sylloge, XXIII, 1925, p. 853.

Peridermium cornui Kleb., Hedwigia, XXIX, 1890, S. 29.

Biol. Cornu, Compt. rend. XXXII, 1886, p. 930; Klebahn, Ber. Deutsch. bot. Ges. VIII, 1890, S. 61; Ztschr. Pflanzenkr. XII, 1902 (32); XV, 1906, p. 83; XVII, 1907, p. 147; Jahrb. Hamburg. wiss. Anst. XX, 1902, S. 21; Wirtswechs. Rostpilze, 1904, S. 372; Fischer, Arch. sci. phys. nat., 1896, p. 101; Ber. Schweiz. bot. Ges. XI, 1901; XII, 1902; Bubák, Centrbl. Bakteriol., II. Abt., XVI, 1906, S. 151; Vanin, Lesn. fitopatol. 1948, p. 136.

Spermagonia not studied; apparently similar to those of **Cronartium ribicola**.

Aecia erumpent from the bark occupy a rather considerable portion of
262 the stems or branches, with a round or elongate, occasionally conspicuous base; peridia 2—3 mm high, 2—8 mm long, 2—3 mm wide, mostly without stiff filaments (see further **Peridermium pini**); walls of peridia of 2 cell-layers; cells almost isodiametric, 16—30 μ across; peridial cell walls

about 4 — 5 μ thick, verrucose; warts on the outer wall somewhat finer. Aeciospores rounded-ellipsoid or angular, 22 — 26 μ (rarely up to 30 μ), 16 — 20 μ wide; walls colorless, most of their surface verrucose on account of the lineate structure, a small portion only reticulate-verrucose, almost smooth, the verrucules here being wide and separated by narrow grooves; the verrucose part of the wall, 3 — 4 μ thick, the smooth part, 2 — 3 μ thick; contents orange-yellow.

FIGURE 73. **Cronartium flaccidum** (Alb. et Schw.) Winter on **Cynanchum**:

1 — urediospores, × 600; 2 — teliospores, × 600; 3 — leaf of **Paeonia anomala** L. infected with **C. flaccidum**, × 5. (Orig.)

Uredia hypophyllous, gregarious, covered with hemispherical peridia which open in a round apical orifice. Urediospores ovoid or ellipsoid, 21 — 27 × 15 — 20 μ; walls colorless, echinulate, with inconspicuous pores; contents yellow.

Telia usually develop from the center of uredia, yellowish-brown, or brown, columnar, 1 — 2 mm long, 60 — 130 μ wide, curved, in the dry state of horny consistency. Teliospores ellipsoid or elongate, 26 — 56 $\times$ 9 — 14 μ, walls thin.

Basidiospores round, about 8 μ in diameter (Figure 73).

Aecia on **Pinus silvestris** L. (section **Diploxylon** Koehne with two needles in the fascicle). Uredio- and teliospores on representatives of different families of dicotyledonous plants. Initially, two species were distinguished: **Cronartium asclepiadeum** Fr. on **Cynanchum** (**Vincetoxicum**), and **C. flaccidum** Winter on **Paeonia**. In 1896, Fischer proved that the two were the same
263 species developing in two different hosts. It is now known that **Cronartium flaccidum** can develop also on **Pedicularis palustris** L. (**Cronartium pedicularis** Lindr.) as well as on several garden plants cultivated in Europe and originating from different parts of the world: **Nemesia** (**Scrophulariaceae**), **Verbena** (**Verbenaceae**), **Impatiens** (**Balsaminaceae**), **Grammatocarpus** (**Loasaceae**), **Tropaeolum** (**Tropaeolaceae**), **Schizanthus** (**Solanaceae**). To this species is probably related also **C. ruelliae** Dietr. on **Ruellia** (**Acanthaceae**), **C. hystrix** Dietr. on **Schizanthus**, and **C. verbenes** Dietr. found in the Estonian SSR. Also related to **C. flaccidum** Winter are, apparently, **C. euphrasiae** Ran., found on **Euphrasia**, in Siberia and in France. In Sweden **Cronartium** was detected on **Melampyrum arvense** (Lagerheim). Compare further **C. gentianeum** Thüm., **C. kamtschaticum** Jørst., and **Peridermium pini** (Willd.) Kleb.

The species is widespread in Europe and Asia (N); in North America it was found only once, on **Impatiens balsamina** L.

On **Pinus silvestris** L. — EUROPEAN PART: Kar.-Lap. (Karelian ASSR, Leningrad Region: Vyborg District), Dv.-Pech. (Arkhangel'sk Region: Vel'sk, Shenkursk), Lad.-Ilm. (Leningrad Region), Balt. (Estonian SSR, Lithuanian SSR), U. V. (Moscow Region, Ivanovo Region: Kineshma), V.-Kama (Kostroma; Gorkii Region), U.Dnp. (Bryansk), M. Dnp. (Kiev Region), U. Dns. (Lvov Region), Crim. (Nature Reserve); W SIBERIA: Ob (Tobol'sk).

On **Pinus pallasiana** Lamb. — EUROPEAN PART: Crim. Biyuk-Uzembash, Simferopol').

On **Cynanchum vincetoxicum** (L.) Pers. (= **Vincetoxicum officinale** Mönch.) EUROPEAN PART: Balt. (Estonian SSR, Lithuanian SSR), U. V. (Kaluga), V.-Kama (Gorkii Region; Tatar ASSR; Sverdlovsk Region), U. Dnp. (Kiev, Chernigov Region), M. Dnp. (Chernigov Region), V.-Don (Tambov, Lipetsk; Gorkii Region; Kharkov), Transv. (Bashkir ASSR), L. Don (Balashov); W SIBERIA: Ob (Tobol'sk).

On **Cynanchum laxum** Bartl. — EUROPEAN PART: Crim. (Uch-Kosh near Yalta); CAUCASUS: Cisc. (Voroshilovsk, Essentuki).

On **Cynanchum scandens** Kusnez. — EUROPEAN PART: Crim. (Nature Reserve).

On **Asclepias cornuti** Dec. (= **A. syriaca** L.) — EUROPEAN PART: U. Dnp. (Kiev); CAUCASUS: Cisc. (Maikop).

On **Paeonia albiflora** Pall. — FAR EAST: Ze.-Bu. (Amur Region), Uss. (Maritime Territory, including Ussuri Region).

On **Paeonia taurica** Andrews — EUROPEAN PART: Crim. (Ai-Petri).

On **Paeonia anomala** L. — EUROPEAN PART: V.-Kama (Kungur, Krasnoufimsk), Urals (Sverdlovsk Region: Chusovaya River); W SIBERIA:

Ob (Sverdlovsk Region; Sosva River; Tomsk), Alt. (Altai: Kolyvanskoe village, Andreevskii settlement); E SIBERIA: Lena-Kol. (Kirensk), Ang.-Say. (Sayans).

On **Paeonia moutan** Sims. — CAUCASUS: W Transc. (Adzhar ASSR: Batumi).

On **Paeonia sp.**, cultivated in gardens — EUROPEAN PART: Leningrad Region, Estonian SSR, Latvian SSR, Lithuanian SSR; Moscow, Smolensk, and Ivanovo regions; Tatar ASSR, Voronezh Region, Ukrainian SSR: Crimea.

On **Pedicularis palustris** L. — EUROPEAN PART: Lad.-Ilm. (Leningrad Region), Balt. (Estonian SSR); W SIBERIA: Ob (Tobol'sk).

264 On **Euphrasia brevipila** Burn. et Gremlin — W SIBERIA: Ob (Tobol'sk).

On **Ruellia formosa** L. — EUROPEAN PART: Balt. (Estonian SSR).

On **Grammatocarpus volubilis** Presl — EUROPEAN PART: Balt. (Estonian SSR).

On **Verbena teucrioides** Gill. et Hook. — EUROPEAN PART: Balt. (Estonian SSR).

The relationship of the aecial stage on **Pinus silvestris** with the other stages (II and III) of the fungus in different hosts has been established by Klebahn (l.c.), Fischer (l. c.), and other authors. It has been experimentally established that this fungus is plurivorous in the uredial and telial stages to a degree unknown among the rust fungi, which usually parasitize in any one stage on a limited number of closely related plants; this rare property aroused the interest of mycologists. In the subsequent years, however, it was established that several fungi are plurivorous in the uredial and telial stages (see species of **Coleosporium**), as well as in the aecial stage (**Puccinia subnitens** Diet. in America; **P. isiacae** Winter and **P. cynodontis** Desm. in Eurasia).

Heavy damage is done by this fungus to the forest economy (Vanin, 1948, p. 136).

Some of the aforementioned habitats of the aecial stage (on **Pinus**) apparently refer to **Peridermium pini** (Willd.) Kleb. This designation was given by Klebahn to the aecial stage, morphologically indistinguishable from aecia of **Cronartium flaccidum** but, as proved by experimental infections, not transferred to any of the plant hosts of stages II and III. Haak, in 1914, and Klebahn, in 1918 (Flora, Neue Folge, XI, 1918, S. 194), showed that aeciospores of **Peridermium pini** Kleb. can directly infect the pine. The description of the fungus by Klebahn is given below.

2. **Peridermium pini** (Willd.) Kleb., Hedwigia, XXIX, 1890, S. 28; Migula, Kryptog.-Fl. Deutschl. III, 1, 1910, S. 459; Klebahn, Kryptogfl. M. Brandb. Va, 1914, S. 727, 900, Fig. L 3 (S. 722); Syd., Monogr. Ured. IV, 1924, p. 5; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 70, 74. — (see **Cronartium flaccidum**).

Spermagonia flat, 2 — 3 mm, irregular in shape, developing under the bark periderm; consist of palisadic spermatiophores. Spermatia are discharged in droplets of a sweet liquid.

Aecia erumpent from the bark in great numbers, usually spread over a rather large area of the shoot, with their bases round, elongate, occasionally flexed or almost branched, 2 — 8 mm long, 2 — 3 mm wide; peridia 2 — 3 mm high, firm above, delicate below, under the arch of the inner scaly or ribbed, mostly slightly stiff filaments attached to the arch and extending through

the spore mass up to the hymen; peridial cells $15-40\mu$ across, sometimes constricted, their walls $5-6\mu$ thick, verrucose over the entire surface. Aeciospores ellipsoid or polyhedral, $25-31 \times 17-22\mu$; the thickness of their walls not uniform: for the most part $3-4.5\mu$ thick, verrucose; a smaller part is thinner, $2-3\mu$ thick, reticulatoverrucose, so that here the warts are considerably broader and separated only by narrow grooves (Figure 74).

On branches of the common pine in western Europe. In the USSR the fungus has not yet been detected (it is apparently regarded as the aecial stage of **Cronartium flaccidum**).

265

On **Gentiana**

3. **Cronartium gentianeum** Thüm., Oesterr. Bot. Ztschr. XXVIII, 1878, S. 193; Hariot, Uréd., 1908, p. 281; Syd., Monogr. Ured. III, 1915, p. 563; Fragoso, Fl. Iber. Ured. II, 1925, p. 306; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 319.

Spermagonia and aecia unknown.

Uredia hypophyllous, pale orange-colored, scattered, minute, round, 0.1 — 0.2 mm in diameter, covered by hemispherical peridia. Urediospores ovoid or ellipsoid, $20-25 \times 17-20\mu$; walls colorless, echinulate; contents yellow.

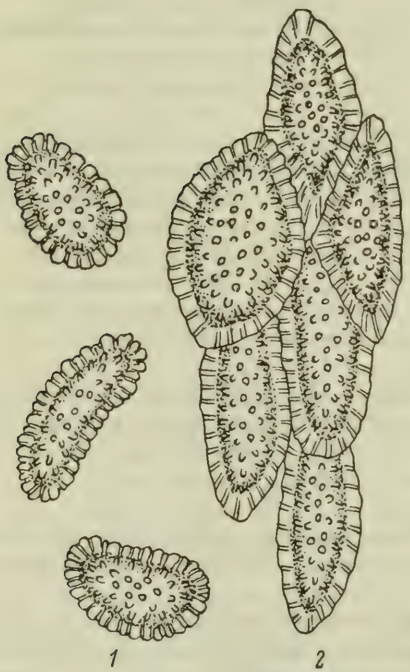


FIGURE 74. Peridermium pini (Willd.) Kleb. on Pinus:

1 — aecia; 2 — peridial cells, × 600. (Orig.)

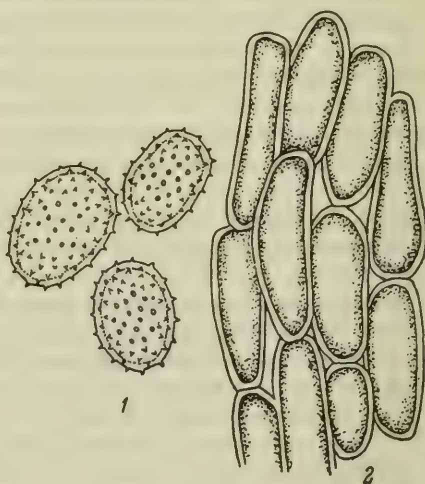


FIGURE 75. Cronartium gentianeum Thüm. on Gentiana:

1 — urediospores; 2 — teliospores, × 600. (Orig.)

Telia hypophyllous, densely covering areas of the leaves, cylindrical, rust brown, 0.5—1.5 mm long, 90—110μ thick. Teliospores prismatic with pointed ends, 35—52 × 10—14μ; walls thin, smooth; contents yellow (Figure 75).

On leaves of **Gentiana asclepiadea** in southeastern Europe, in Transcaucasia. This species is very close to **Cronartium flaccidum**, but transfer of the latter onto **Gentiana asclepiadea** failed in experimental infections carried out by Fischer and Klebahn.

On **Gentiana asclepiadae** L. — CAUCASUS: W Transc. (Georgian SSR: Tsebel'da), E Transc. (Georgian SSR: Borzhomi).

On Castilleja and Pedicularis

4. **Cronartium kamtschaticum** Jørst., A Study on Kamtchatka Uredinales in Skrifter utgitt av det Norske Videnskaps-Akad. Oslo. I. Math.-Naturvid. Klasse, No. 9, 1933, p. 27; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 70, 73, 335.

266 Syn.: ? **Peridermium kurilense** Diet. in Engler's Bot. Jahrb. XXXVII, 1905, S. 107; Sacc., Sylloge, XXI, 1912, p. 749; Syd., Monogr. Ured. IV, 1924, p. 7; Colley a. Taylor, Journ. Agric. Res. XXXIV, 1927, p. 39.

Spermagonia not described.

Aecia on pine branches causing fusiform thickening, at times confluent, bladderlike or elongate, 2—6 mm long, up to 2.5 mm high; peridia consisting of 2—3, occasionally 4 layers of cells; near the top of peridium the cells of the outer layer measure 45.4—61.3 × 30.6—42.8μ (on an average, 53.3 × 38.3μ), their outer wall smooth, up to 13.7μ thick, the inner wall verrucose. Aeciospores obovoid to ellipsoid, 23.8—30.8 × 19.1—23.7μ (according to Dietel, 25—40 × 17—27μ; according to Sydow, 24—36 × 16—24μ); on an average, 27.8 × 21.4μ; wall 4.24μ (3.36—5.18μ) thick, part verrucose and part smooth.

Uredia hypophyllous, round, 0.125—0.210 mm across, yellowish-brown, covered by hemispherical peridia. Urediospores subgloboid or ellipsoid, 20—29 × 17—20μ; wall colorless, echinulate.

Telia hypophyllous, thickly set, cylindrical, straight or curved, up to 1 mm long, 55—230μ thick, rust-brown. Teliospores oblong, pointed at both ends, up to 75μ long, 10—17μ thick, smooth.

Basidiospores subgloboid or ovoid, 11—13 × 10μ.

Aecia on **Pinus pumila**. Uredio- and teliospores on **Castilleja** and **Pedicularis**.

Related to the same species is **Cronartium pedicularis**, found in S Sakhalin (on **Pedicularis resupinata**) and in Japan. This species is labeled in catalogs and herbaria either as **Cronartium pedicularis** Lindr., or as **C. coleosporioides** (D. et H.) Arth. The former is encountered in eastern Europe and in Siberia, near Tobol'sk, on species of **Pedicularis**, appearing identical with **Cronartium flaccidum**; the latter was found in the western parts of North America, on species of **Castilleja**, **Pedicularis**, and other representatives of the family **Scrophulariaceae**.

The aecial stage is very similar in both species, developing on pines of subgenus **Diploxylon** Koehne, while in Kamchatka only one pine species occurs — **Pinus pumila** Regel, belonging to the subgenus **Haploxylon** Koehne.

On this basis Jørstad separated the Kamchatkan fungus into a separate species of **Cronartium**, and maintained that the aecia on **Pinus pumila** in the Kuril Islands, described under the name **Peridermium kurilense** Diet., belong to this species. In the description of **P. kurilense** Dietel showed that according to the aecia the species is close to **Cronartium ribicola**, and is distinguished by "significantly larger spores, $25-40 \times 17-27\mu$."

Colley and Taylor (Jour. Agric. Res. XXXIV, 1927, pp. 300 — 329) reexamined the original specimen of **Peridermium kurilense** and supplied a detailed description, stating therein that the mean spore size is $27.3 \times 21.4\mu$, while in general the spore size fluctuates between $23.8-30.8 \times 19.1-23.7\mu$. The same authors (pp. 529 — 530) examined aecia referred to **Cronartium ribicola**, and found that the mean size of the spore is $24.2 \times 18.3\mu$ ($23.1-25.3 \times 17.2-19.4$). Evidently, no significant differential data concerning the spores are gained by biometric studies. More significant is the difference in thickness of the outer wall in the external cell layer of the peridium,
267 between **Peridermium kurilense** (13.77μ) and **Cronartium ribicola** (7.16μ). Tranzschel reexamined the specimens of aecia on **Pinus pumila** from Kamchatka and could not find outer (smooth) peridial cell walls thicker than 7.5μ.

On **Pinus pumila** Rgl. — FAR EAST: Kamch., Sakh. (Kuril Is.).

On **Castilleja pallida** (L.) Kunth. — E SIBERIA: Lena-Kol. (Yakut ASSR; Meginskii Ulus).

On **Pedicularis resupinata** L. — FAR EAST: Kamch., Sakh. (S Sakhalin).

On **Pedicularis chamissonis** Stev. — FAR EAST: Kamch.

On Scrophulariaceae

5. **Cronartium coleosporioides** (D. et H.) Arth. in N. Amer. Fl. VII, 1907, p. 123; Sacc., Sylloge, XXI, 1912, p. 606; Syd., Monogr. Ured. III, 1915, p. 564, tab. XXVIII, fig. 181; Arth., Manual Rusts U. S. a. Canada, 1934, p. 29, fig. 40; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 335, 336.

Syn.: **Cronartium Harknessii** (J. P. Moore) Meinecke, Phytopathology, X, 1920, p. 282; Arth., N. Amer. Fl. VII, 1925, p. 694.

Cronartium stalactiforme (Arth. et Kern) Arth. et Kern, Bull. Torrey Bot. Club, XLIX, 1922, p. 191.

Cronartium filamentosum (Peck) Hedgc., Phytopathology, II, 1912, p. 177.

Peridermium Harknessii J.P. Moore, 1876.

Peridermium filamentosum Peck, 1882.

Peridermium stalactiforme Arth. et Kern, 1906.

Biol. Hedgcock, Phytopathology, II, 1912, p. 176, 250; Meinecke, Phytopathology, III, 1913, p. 167; VI, 1916, p. 232; X, 1920, p. 286; XIX, 1929, p. 331, 339; Weir a. Hubert, Phytopathology, VII, 1917, p. 106, 107; Journ. Agric. Res. V, 1915, p. 782.

Spermagonia on stems and branches, spread over large areas producing small swellings.

Aecia on stems and branches involving large areas; their structure is not quite homogenous; the following forms of aecia are known: 1) not eliciting swellings in the host, peridia cylindrical, extruded in filaments pulling lengthwise through the spore mass (**Per. filamentosum**); 2) eliciting

small swellings, with flat peridia and filaments penetrating upward and downward halfway through the spore mass (**Per. stalactiforme**); 3) eliciting large, round or ring-shaped swellings, peridia flattened with very short filaments, if at all (**Per. harknessii**). Aeciospores prismatic, obovoid-prismatic, or ellipsoid, $23-35 \times 14-24\mu$; wall colorless, $2.5-4\mu$ thick, densely verrucose; on some spores smooth areas are noticed on one side, toward the base.

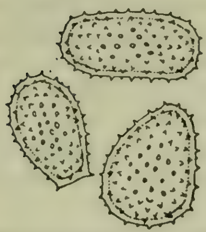


FIGURE 76. **Cronartium coleosporioides** (D. et H.) Arth. on **Castilleja latifolia** H. et A. Urediospores, × 600. (Orig.)

Uredia hypophyllous and caulicolous, small, round; peridia opening by a central pore. Urediospores globoid or broad-ellipsoid, $17-27 \times 14-22\mu$; wall almost colorless, $1.0-1.5\mu$ thick, sparsely and finely aculeate (Figure 76).

Telia hypophyllous cylindrical, short, 0.5–1.0 mm. Teliospores prismatic or fusiform, $30-52 \times 12-17\mu$, blunt at both ends; wall almost colorless, 1μ thick, smooth.

268 On species of **Castilleja, Cordylanthus** (**Adenostegia**), **Orthocarpus**, and **Pedicularis** of the family **Scrophulariaceae** in North America, from Alaska to Mexico in the west, and to the western corner of Nebraska in the east. Aecia on species of **Pinus** from the subgenus **Diploxylon** (sections **Australes, Insignes**, and **Macrocarpae** Shaw) in three different forms, all of which pass onto **Castilleja**. Some of them may pass directly onto pines, as already mentioned for **Peridermium pini**. In connection with the different aecial stages, this species may be considered as consisting of three varieties or species (see Arthur, Bull. Torrey Bot. Club, XLIX, 1922, p. 194). Not found in the USSR.

The biology of the fungus was studied in detail by American scientists, particularly by Meineke.

On Fagaceae (Quercus, Castanea)

6. **Cronartium quercus** (Brond.) Arth., N. Amer. Fl. VII, 1907, p. 122; 1925, p. 691 (sub **Cronartium quercus** Schroet.); Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 70, 73, 161.

Syn.: **Cronartium quercuum** Miyabe ex Shirai, Bot. Mag. Tokyo, XIII, 1899, p. 74, tab. IV, V; Grove, Brit. Rust Fungi, 1913, p. 315, fig. 239; Syd., Monogr. Ured. III, 1915, p. 573; Fragoso, Fl. Iber. Ured. II, 1925, p. 307; Arth., Manual Rusts U. S. a. Canada, 1934, p. 25, fig. 36.

Uredo quercus Brond. ex Duby, Bot. Gallis. II, 1830, p. 893; Fischer, Ured. Schweiz, 1904, S. 539; Hariot, Uréd., 1908, p. 308; Trotter, Fl. Ital. Crypt. Ured., 1914, p. 451.

Peridermium cerebrum Peck, Bull. Buffalo Soc. Nat. Sci. I, 1873, p. 68.

Peridermium giganteum Tub. et **P. deformans** Tub., Pflanzenkrankh. 1895, S. 429, Fig. 15, 226, 227.

Melampsora quercus Schroet. ex Saccardo, Michelia, II, 1881, p. 308 (non vidi); De-Toni in Sacc., Sylloge, VII, 1888, p. 594.

Biol. Shirai, Bot. Mag. Tokyo, XIII, 1899, p. 75, tab. IV, V; Shear, Journ. Mycol. XII, 1906, p. 89; Arth., Journ. Mycol. XIII, 1907, p. 194; Mycologia, IV, 1912, p. 26; Hirats., Japan. Journ. Bot. VI, 1932, p. 25.

Spermagonia on branches and trunks scattered under the bark on swellings on which they appear later, 40 — 50 μ high. Spermatia globoid, 1.5 — 2 μ in diameter.

Aecia on globoid, rarely fusoid or irregularly shaped perennial bladders (up to 25 cm across), on branches and trunks, numerous, arranged in twisted or sinuous rows, large, irregular, 3 — 10 mm long; peridia tearing on each side, soon disappearing, consisting of two cell layers; outside surface of peridia smooth, inside verrucose; cell walls greatly thickened. Aeciospores obovoid or ellipsoid, 25 — 32 × 17 — 23 μ; external wall colorless, 2.5 — 3.5 μ thick, coarsely verrucose except for the base and one side which are smooth; contents orange-yellow.

Uredia hypophyllous, scattered or in groups, small, about 0.25 mm across, hemispherical, covered by a very delicate peridium which opens widely at the top, yellow. Urediospores obovoid or ellipsoid, 20–32 × 12–21 μ; external wall colorless, 2–3 μ thick, echinulate.

269

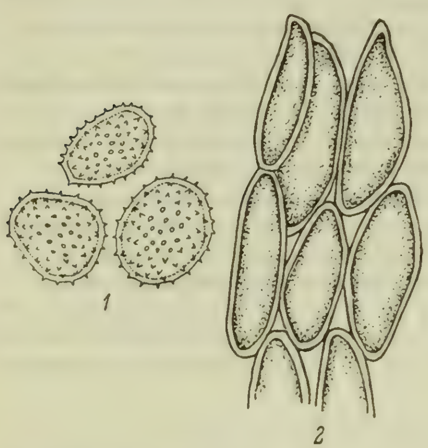


FIGURE 77. Cronartium quercus (Brond.) Arth. on Quercus sp.:

1 – urediospores, 2 – teliospores, × 600. (Orig.)

Telia hypophyllous, in a filamentous column, 2 — 3 mm long, 100 — 175 μ thick, brown, straight or curved. Teliospores elongated or fusoid, 30–40 × 14–20 μ; external wall almost colorless, smooth, 2 — 3 μ thick (Figure 77).

On species of **Quercus, Castanea, Pasania**. Aecia on various species of **Pinus** of the subgenus **Diploxylon**; in Japan on species of section **Lariciones**, in North America as far south as Central America on species of sections **Australes** and **Insignes**, in the northeastern United States and in Canada also on **Pinus silvestris** L. of section **Lariciones** (Far East).

General distribution: western Europe (only in the uredial stage), China, Japan, North America.

On **Pinus silvestris** L. — FAR EAST: Ze.-Bu. (Amur Region: near Blagoveshchenk (large galls without aecia); Chita Region: Zeya District, Ovsyankovskii forestry (remnants of aecia with aeciospores)).

On **Quercus mongolica** Fisch. — FAR EAST: Ze.-Bu. (Amur Region: near the city of Svobodnyi — with teliospores).

All these localities lie near the junction of the western boundary of **Quercus mongolica** with the eastern boundary of **Pinus silvestris**. In the area of distribution of **Pinus funebris** Kom. the fungus has not yet been found, although it occurs in Japan on closely related species: **P. densiflora** S. et Z., and **P. thunbergii** Parlat. In America two aecial forms are also encountered which develop exclusively on pine cones and infect oak leaves; these two fungi have been described as separate species, but Arthur (Manual, l. c.) united them in **Cronartium quercus**.

The connection between the aecial stage on the globoid galls on pines and the uredio- and teliospores on oaks was established in Japan by

Shirai (l. c.). Hiratsuka (l. c.) experimentally infected with aeciospores from **Pinus densiflora** nine species of oak (Quercus acuta was not susceptible to infection), **Castanea mollissima** Blume, and **Pasania sieboldiana** (Blume) Nakai.

In North America aeciospores from pines were successfully sown on oak leaves by Shear, Arthur, and others.

On **Ribes**

7. **Cronartium ribicola** Dietr., Arch. Naturk. Liv.-, Ehst- u. Kurlands, 2 Ser., I, 4, 1856, S. 287; Fischer, Ured. Schweiz, 1904, S. 433, Fig. 296; Hariot, Uréd., 1908, p. 281; Migula, Kryptog.-Fl. Deutschl. III, 1, 1910, S. 459, Taf. IX J, Fig. 4; Taf. IX K, Fig. 4; Klebahn, Kryptogfl. M. Brandb. Va, 1914, S. 718, Fig. L1; Trotter, Fl. Ital. Crypt. Ured., 1914, p. 363; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 70, 73, 211.

Syn.: **Cronartium ribicola** Fisch., Rabenhorst, Fungi europ. No. 1595 et in Hedwigia, XI, 1872, S. 182; Arth., N. Amer. Fl. VII, 1907, p. 122; 1925, p. 692; Grove, Brit. Rust Fungi, 1913, p. 55, 316, fig. 34, 240; Syd., Monogr. Ured. III, 1915, p. 567; Fragoso, Fl. Iber. Ured. II, 1925, p. 305, fig. 147; Arth., Manual Rusts U. S. a. Canada, 1934, p. 26, fig. 37.

Peridermium strobi Kleb., Abhandl. Naturwiss. Ver. Bremen X, 1887,
270 S. 153.

Biol. Klebahn, Ber. Deutsch. bot. Ges. VI, 1888, S. XLVIII; Vanin, Lesn. fitopatol., 1934, p. 146.

Spermagonia flat, 2—3 mm, irregularly shaped, developing under the bark, with some of its pustular elevations exuding through inconspicuous slits in the bark drops of a sweet fluid with the spermatia; spermatophores about 40 μ long, vertical, developing in June and August.

Aecia on somewhat thickened areas of branches and trunks, emerging in great numbers from under the bark, with round, oblong or curved bases, 2—7 mm long, 2—3 mm wide, 2.0—2.5 mm high; peridia bladder-shaped rupturing irregularly, without stiff filaments, in 2—3 cell layers; outer walls of peridial cells smooth, up to 7 μ thick, inner walls thinner, 3–4 μ thick, verrucose. Aeciospores ovoid to ellipsoid, 22–29 × 18–20 μ (on an average 24 × 18 μ); external wall colorless, verrucose over most of the spore, 2–2.5 μ thick, smooth on a smaller portion, 3–3.5 μ thick; contents orange-colored.

Uredia hypophyllous, in groups, covered by hemispherical peridia and the epidermis. Urediospores ellipsoid, 1—30 × 13—18 μ; external walls colorless, echinulate, about 1.5 μ thick; contents orange-yellow.

Teliospores hypophyllous, usually arising from the center of uredia, cylindrical, mostly curved, up to 2 mm long, 120—150 μ across, at first orange-yellow, later yellowish-brown. Teliospores oblong or cylindrical, 30—60 × 11—16 μ; external wall almost colorless, smooth, 2—3 μ thick (Figure 78).

Aecia on **Pinus**; uredio- and teliospores on many species of **Ribes**.
271 The fungus originates, apparently, from northern Asia. In Europe the fungus was first found in Estonia, in 1854, and later (in 1870) detected in St. Petersburg; at present it occurs throughout Europe, in Siberia and the Far East; at the beginning of the 20th century it was introduced in North America (with **Pinus strobus**). The aecial stage was found in 1854, in

Estonia, on the American Weymouth pine, **Pinus strobus** L. This pine species is readily and severely attacked; the fungus spreads together with this host. Aecia are found in Europe in gardens on the American pine species, **P. monticola** D. Don., and **P. lambertiana** Dougl. In Japan the aecia are found on **P. pentaphylla** Mayr (= **P. parviflora** S. et Z.); in North America, on **P. strobus** in the east, and on **P. monticola** in the west.

The Siberian cedar pine, **Pinus sibirica** Mayr (**P. cembra** L. var. **sibirica** Rupr.) represents the initial host of the aecial stage, and possibly also **P. cembra** L. On the latter the fungus was first found in the Swiss Alps, in 1903. All pine species named belong to the subgenus **Haploxylon**. Concerning the aecia on **Pinus pumila** (Pall.) Reg., see **Cronartium kamtschaticum** Jørst. In the western parts of North America, from Washington State to northwestern Kansas and central Nevada, a closely related species is encountered — **Cronartium occidentale** Hedgc., Bethel et Hunt — on species of **Ribes** with aecia on **Pinus edulis** Engelm., and **P. monophyla** Torr. et Frem. These pines are related to the subgenus **Haploxylon** section **Paracembra**.

The literature concerning **Cronartium ribicola**, which is extremely injurious to the American Weymouth pine as well as to currants, is very extensive. In the control of this fungus preventive measures are held to be the most important (Vanin, 1934; Bondartsev, "Bolezni kul'turnykh rastenii" (Diseases of Cultivated Plants, 1931, p. 239)).

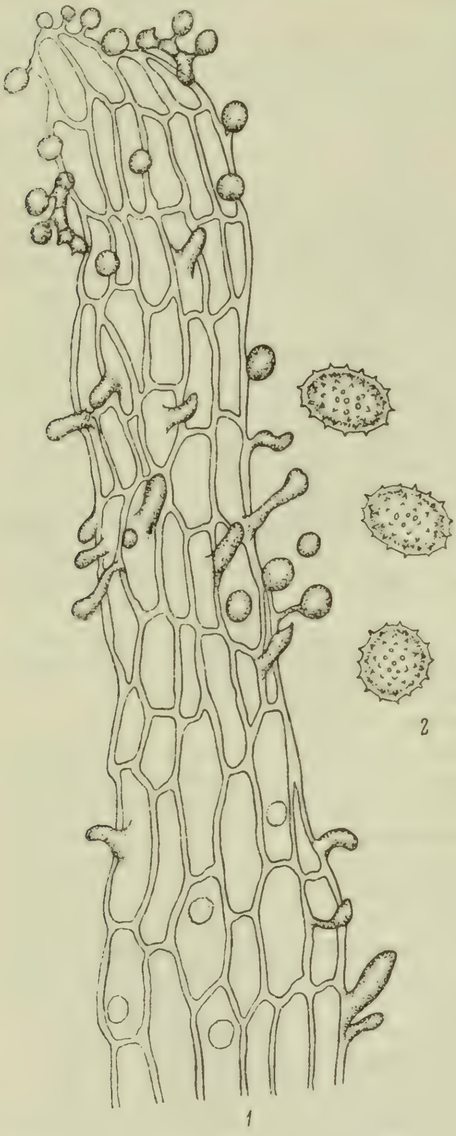


FIGURE 78. **Cronartium ribicola** Dietr. on **Ribes atropurpureum** C. A. M.:

1 — a column of teliospores germinating at the top;
2 — urediospores, × 450. (Orig.)

General distribution: Europe, Asia (N), North America.

On **Pinus strobus** L. — EUROPEAN PART: Lad.-Ilm. (Leningrad Region), Balt. (Estonian SSR, Lithuanian SSR), U. V. (Moscow Region; Yaroslav'l), U. Dnp. (Kiev), M. Dnp. (Kursk Region; Shchigry; Ukrainian SSR: Priluk, Uman).

On **Pinus sibirica** (Rupr.) Mayr. (= **P. cembra** var. **sibirica** Rupr.) — EUROPEAN PART: Lad.-Ilm. (Leningrad Region: Leningrad, Staryi

Petergof, etc.), V.-Kama (Tatar ASSR: Kazan; Molotov), V.-Don (Tula); W SIBERIA: Irt. and Alt. (Altai).

On **Pinus flexilis** — EUROPEAN PART: Balt. (Lithuanian SSR: Kaunas, Botanical Garden).

On **Ribes vulgare** Lam. (cult.) — EUROPEAN PART: Lad.-Ilm. (Leningrad Region), Balt.(Estonian SSR), U. V. (Moscow), M. Dnp. (Kursk); FAR EAST: Maritime Territory (Nadezhdinskaya, in garden).

On **Ribes manshuricum** (Max.) Kom. — FAR EAST: Uss. (Maritime Territory).

On **Ribes palczewskii** Pojark. — FAR EAST: Uss. (Khabarovsk).

On **Ribes rubrum** L. (= R. glabellum Hedl.) — EUROPEAN PART: Balt. (E Latvian SSR (?)), Dv.-Pech. (Komi ASSR: Shchugor River); W SIBERIA: Ob (Omsk Region: basin of Severnaya Sosva River); E SIBERIA: Ang.-Say (Minusinsk), Dau. (Verkhne-Angarsk, Kyakhta).

On **Ribes hispidulum** Pojark. — W SIBERIA: Ob (Tobol'sk, Tomsk, Krasnoyarsk).

On **Ribes latifolium** Jancz. — FAR EAST: Sakh. (S Sakhalin).

On **Ribes pallidiflorum** Pojark. — FAR EAST: Uss. (Maikhe and Ugedinze rivers).

On **Ribes altissimum** Turcz. — E SIBERIA: Ang.-Say. (Mount Borus and the Sayans).

272 On **Ribes atropurpureum** C. A. M. — W SIBERIA: Altai.

On **Ribes nigrum** L. — EUROPEAN PART: Kar.-Lap. (Karelian ASSR; Vyborg), Dv.-Pech. (Komi ASSR: Ilych River, tributary of Pechora), Lad.-Ilm. (Leningrad Region), Balt. (Estonian SSR, Latvian SSR, Lithuanian SSR), U. V. (Kalinin, Moscow, and Ivanovo regions), V.-Kama (Kirov Region; Tatar ASSR; Sverdlovsk Region: Krasnoufimsk District), U. Dnp. (Smolensk Region, Belorussian SSR; Ukrainian SSR: Chernigov Region), V.-Don. (Tula, Orel, Voronezh, Kursk, Tambov, and Kharkov regions), Transv. (Bashkir ASSR); W SIBERIA: Ob (Omsk Region: Severnaya Sosva River; Tomsk), Irt. (Ishim, Barabinsk, Altai); E SIBERIA: Lena-Kol. (Chita Region), Ang. -Say.(Krasnoyarsk, Minusinsk, Lake Baikal; FAR EAST: Ze.-Bu. (Zeya River).

On **Ribes dikuscha** Fisch. var. **appendiculata** Krylow (cult.) — W SIBERIA: Ob (Tomsk, Botanical Garden).

On **Ribes procumbens** Pallas — E SIBERIA: Ang.-Say. (Irkutsk Region: Ishim River, Chora River, former Kirensk County); FAR EAST: Uda (Nikolaevsk on the Amur).

On **Ribes aureum** Pursh (cult.) — EUROPEAN PART: Lad.-Ilm. (Leningrad Region), Balt. (Estonian SSR, Latvian SSR), U. V. (Moscow Region), V.-Kama (Kirov), M. Dnp. (Chernigov Region: Priluki), V.-Don. (Orel, Voronezh, Tambov; Kharkov Region); W SIBERIA: Ob (Omsk, Tomsk).

On **Ribes diacantha** Pall. — E SIBERIA: Dau. (Kyakhta).

On **Grossularia reclinata** (L.) Mill. (= **Ribes grossularia** L., cult.) — EUROPEAN PART: Balt. (Lithuanian SSR), U. V. (Moscow Region; Podol'sk District), V.-Kama (Molotov).

The connection between the aecia on Weymouth pines and the urediospores on **Ribes** species was established by Klebahn, in 1888, and later confirmed by other authors.

III. Subfamily (Tribe) CHRYSOMYXEAE

Aecia of heteroecious species on leaves (needles) of spruce (**Picea**) or of phanerogams (**Cerotelium**). Urediospores mostly in short chains. Uredia devoid of protective peridia. Teliospores joined in chains, occasionally branching, forming naked, compact cushions, or with a pulverulent surface. Each cell in the chain gives rise to a free 4-celled promycelium.

The subfamily comprises 4 genera, of which the most ancient is the genus **Chrysomyxa**, with heteroecious species, confined to **Picea** and evergreen plants of the families **Pirolaceae**, **Ericaceae**, and **Empetraceae**. Genera **Cerotelium** and **Pucciniostele** ranging mainly, or exclusively, in warm countries have, apparently, evolved from forms analogous to the contemporaneous **Chrysomyxa**. The life cycle of species of **Pucciniostele** and **Baeodromus** proceeds on a single host; some species of **Cerotelium** are heteroecious.

V. G. Tranzschel (see Tranzschel, Consp. Ured. URSS, pp. 30—32) referred the abovementioned three genera to the family **Pucciniaceae**. However, production of teliospores (in chains), the presence of peridia around the uredia (**Pucciniostele**, **Cerotelium**), and the difference between individual generations of teliospores (**Pucciniostele**) brings these fungi close to representatives of the family **Melampsoraceae**. The teliospores, freely separating from the surface of the mature sorus, reflect the advanced development of these fungi.

273 Key to Genera of Subfamily **Chrysomyxeae**

I. Telia orange-yellow, waxy, compact, not pulverulent; on leaves (needles) of **Picea** or on species of families **Pirolaceae**, **Ericaceae**, and **Empetraceae** . . . . 11. **Chrysomyxa** Unger.
II. Telia orange-red, shiny, convex, resembling III **Coleosporium**; on species of **Astilbe** and **Ampelopsis**. . . . . 12. **Pucciniostele** Tranz. et Kom.
III. Telia waxy, brittle after maturation, readily pulverized, whitish; on **Urticaceae**, **Moraceae**, and other families in warm countries . . . . 13. **Cerotelium** Arth.
IV. Telia with pulverulent surface, brownish; on **Eupatorium** and **Senecio** in America . . . . 14. **Baeodromus** Arth.

11. Genus CHRYSOMYXA Unger

Unger, Beitr. vergl. Pathol., 1840, S. 24.

Some of the species referred to this genus develop only teliospores (**Chrysomyxa** Unger s. str.) on spruce needles, and some are heteroecious (**Melampsoropsis** Arth.) with spermagonia and aecia on spruce needles, and with the teliospores and, in great part, with the urediospores on evergreen plants of the families **Pirolaceae**, **Ericaceae**, and **Empetraceae**.

Spermagonia and aecia on **Picea**.

Spermagonia globoid, sunken into the leaf tissue, orange-red, later darkening.

Aecia with colorless peridia, laterally constricted; inner wall of peridial cells smooth, outer wall verrucose. Aeciospores ellipsoid or globoid, in chains; spore wall colorless, in optical section through the inclusion rods — striate, verrucose on the surface; rods easily removed; contents orange-yellow.

Uredia in early stages occasionally covered by peridia which are removed together with the epidermis at dehiscence; paraphyses absent. Urediospores in chains, similar in structure to aeciospores.

Telia develop in the spring, orange-yellow, pulvinate, waxy. Teliospores in chains, unicellular; individual cells in the chain, like the chains themselves, are firmly joined to each other; spore wall smooth, colorless. Teliospores germinate soon after their appearance in the spring.

Basidia 4-celled. Basidiospores globoid.

There are 21 known species and 3 doubtful species distributed in Europe, Asia, and North America. Of these, 13 species are found in the USSR, i.e., all except the 4 (+ 1) species endemic in North America, 2 species endemic in Japan, and 2 (+1) species endemic in India. It should be noted that **Chrysomyxa deformans**, known to be confined to the Himalayas, and **C. weirii**, until now known only in North America, are present in the mountains near Alma-Ata.

Key to Species of **Chrysomyxa**

I. Only telia, on species of **Picea** — **Chrysomyxa** Unger s. str.
   A. Telia developing on all leaf buds, rupturing in the spring . . . . 1. **C. deformans** (Diet.) Jacz.
274 B. Telia on overwintered leaves.
      1. Telia break up rather easily into individual spores. . . . . 2. **C. weirii** Jackson.
      2. Telia compact, teliospores separating from each other only with difficulty. . . . . 3. **C. abietis** (Wallr.) Unger.
II. Teliospores on leaves of evergreen dicotyledonous plants, the majority of species producing also uredia and aecia (the latter on spruce).
   A. Sori on diffuse mycelium covering entire frond.
      1. Teliospores on **Ledum**. . . . . 4. **C. woroninii** Tranz.
      2. Teliospores on **Rhododendron** . . . . . 5. **C. komarovii** Tranz.
      3. Uredio- and teliospores on **Pirola**.
         a. Sori developing only on overwintered leaves, densely covering the entire leaf surface. . . . . . . 6. **C. pirolae** (DC) Rostr.
         b. Sori developing also on leaves of current year, on which they are loosely scattered, while densely covering last year's leaves . . . . 7. **C. ramischiae** Lagerh.
   B. Uredia and telia on local mycelium on limited areas of leaves.
      1. On **Ledum**, uredia and telia.
         a. Sori hypophyllous . . . . . 8. **C. ledi** (Alb. et Schw.) de Bary.
         b. Sori epiphyllous . . . . 9. **C. ledicola** (Peck) Lagerh.

2. On Rhododendron.
  a. Telia flat, confluent. . . 10. C. rhododendri (DC) de Bary.
  b. Telia expanding into a cap on a short pedicel . . . . 11. C. succinea (Sacc.) Tranz.
3. On Chamaedaphne (Cassandra) calyculata . . . . 12. C. cassandrae (Peck et Clint.) Tranz.
4. On Empetrum . . . . 13. C. empetri (Pers.) Schroet.

C. On Arctostaphylos . . . . 14. C. arctostaphyli Diet.

On Picea

1. Chrysomyxa deformans (Diet.) Jacz., Jaczewski, Izv. Leningr. Lesn. Inst. XXXIII, 1926, p. 131, 148, fig. 1—3; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 91, fig. 13a.

Syn.: Barclayella deformans Diet., Hedwigia, XXXI, 1890, S. 266; Sacc., Sylloge, IX, 1891, p. 316; Syd., Monogr. Ured. III, 1915, p. 522, tab. XXIII, fig. 169.

Aecia unknown.

Telia covering from all sides the shoots emerging from the buds in the spring; insignificant elongation of internodes causes infected leaves to remain close together (in India infection of young cones was reported); sori waxy, pulvinate, elongate on the upper side of the leaves which they entirely cover with two rows; shorter, individual sori on the underside of leaves,
275 orange-red. Teliospores in chains, relatively readily separating, ellipsoid or oblong, frequently slightly tapering downward, ovoid, $14-18 \times 10-16\mu$; wall thin, colorless; contents orange-yellow (Figure 79).

Basidiospores globoid or broad-ovoid bearing a short beak at the base, $13 \times 12\mu$.

Dietel separated this species into a special genus, Barclayella, as he considered abnormal the catenulate 4-celled basidium arising from the germinating teliospores. Jaczewski (1926) noted also sterigmata on the basidia, while Tranzschel recorded typical 4-celled basidia, three cells of which were carried on sterigmata of the basidiospore.

The fungus was described on Picea moringa from the western Himalayas. In the USSR it was found on Picea schrenkiana Fisch. et Mey.— CENTRAL ASIA: in Kazakhstan, in the Trans-Ili Ala-Tau near Alma-Ata; in Kirghizia on the northern slopes of the Kirghiz Range, the southern slopes of the Kungei Ala-Tau Range, near Frunze, and in the Terskei Ala-Tau Range near Przheval'sk.

2. Chrysomyxa weirii Jackson, Phytopathol. VII, 1917, p. 353; Weir, Mycologia, XV, 1923, p. 184, tab. XVII; Arth., N. Amer. Fl. VII, 1925, p. 690; Manual Rusts U.S. a. Canada, 1934, p. 32, fig. 44; Tranzschel,
276 Consp. Ured. URSS, Moscow, 1939, p. 72.

Aecia unknown.

Telia on yellow areas of last year's leaves, waxy, pulvinate, surrounded by the torn epidermis, oblong, 0.5—1.5 mm long, occasionally confluent, orange-yellow or brownish. Teliospores in chains, readily detaching, prismatic, frequently with tapered ends or fusiform, $16-28 \times 5-8\mu$; wall colorless, thin, smooth (Figure 80).

(275)

FIGURE 79. **Chrysomyxa deformans** (Diet.) Jacz. on **Picea schrenkiana** Fisch. et Mey.:

1 — infected shoot; 2 — section through cushion of teliospores, × 120; 3 — teliospores, × 600. (Orig.)

(276)

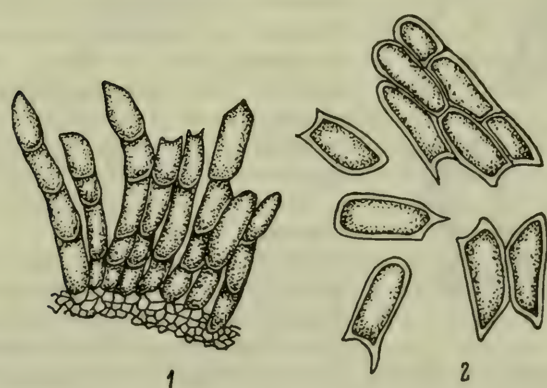


FIGURE 80. **Chrysomyxa weirii** Jackson on **Picea schrenkiana** Fisch. et Mey.:

1 — section through cushion of teliospores, × 120; 2 — teliospores, × 600. (Orig.)

The species was described on **Picea engelmanni** Engelm. in northwestern North America, and is also passing over onto **Picea rubens** Sarg. in the Allegheny Mts. in eastern North America. In the USSR specimens are found corresponding to those described[1] on **Picea schrenkiana** Fisch. et Mey — CENTRAL ASIA: Tien Shan, in Kazakhstan, in the Trans-Ili Ala-Tau along the Bol'shaya Almatinka River, below the lake, on May 14, 1916 (R. Abolin) and in the Voroninaya Crevasse, June, 1936 (G. Nevodovskii).

Zaprometov, in Materialy po mikoflore Srednei Azii (Materials on Mycoflora of Central Asia), I, 1926, p. 25, reported **Chrysomyxa abietis** (Wallr.) Unger on **Picea excelsa** in the city of Skobelev [Fergana] and the [former] Alma-Ata and Karakol counties; both host and parasite are, apparently, incorrectly determined and refer to **Chrysomyxa weirii**.

On Abies

3. **Chrysomyxa abietis** (Wallr.) Unger, Beitr. vergl. Pathol., 1840, S. 24; Sacc., Sylloge, VII, 1888, p. 762; Fischer, Ured. Schweiz, 1904, S. 429; Hariot, Uréd., 1908, p. 283; Liro, Ured. Fenn., 1908, p. 452; Migula, Kryptog.-Fl. Deutschl. III, 1, 1910, S. 457, Taf. IX G, Fig. 2—4; Klebahn, Kryptogfl. M. Brandb. Va, 1914, S. 712, Fig. K3 (S. 722); Trotter, Fl. Ital. Crypt. Ured. 1914, p. 361; Syd., Monogr. Ured. III, 1915, p. 519; Fragoso, Fl. Iber. Ured. II, 1925, p. 296; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 69, 70, 72.

277 Syn.: **Blennoria abietis** Wallr., Allg. Forst. u. Jagdztg. 17, 1834, S. 65.

Aecia unknown.

Telia on underside of last year's leaves, on yellow areas, pulvinate, frequently elongate, orange-red, occasionally brownish. Teliospores in compact chains, oblong, with blunt ends, $20-30 \times 12-16\mu$; walls colorless, thin; contents orange-red (Figure 81).

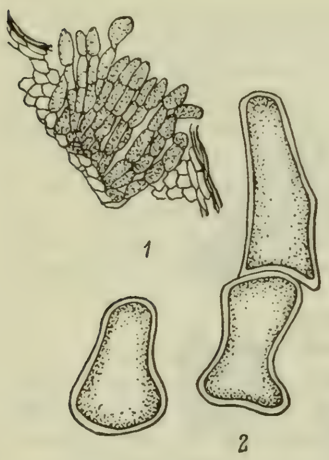


FIGURE 81. **Chrysomyxa abietis** (Wallr.) Unger on **Picea excelsa** Link:

1—section through cushion of teliospores, × 120; 2—teliospores, × 600. (Orig.)

The fungus occurs on **Picea excelsa** Link almost throughout Europe. It was recorded also on **P. engelmanni** Engelm. and **P. pungens** Engelm. in European gardens, and on **P. glehnii** Mast. in Japan. In the early summer basidiospores infect young shoots on the leaves of which yellow transverse stripes appear in the fall, while teliospores are produced toward spring.

General distribution: Europe, Japanese Islands.

On **Picea excelsa** Link — EUROPEAN PART: Kar.-Lap., Lad.-Ilm. (Leningrad Region, Kalinin Region), Balt. (Estonian SSR, Lithuanian SSR, Latvian SSR), U. V. (Moscow Region, Smolensk Region), U. Dns. (Stanislav Region, Chernovtsy Region).

Reports about this species in Central Asia probably refer to **Chrysomyxa weirii**.

[1] Weir (l. c., 1923) described the telia as either high or low, while our samples are low and elongate; maybe our samples should be considered a new species.

On Picea, Ledum

4. **Chrysomyxa woroninii** Tranz., Tranzschel, Tr. Bot. Muzeya Akad. Nauk, II, 1905, p. 23; Centrbl. Bakteriol. II. Abt., XI, 1903, S. 106, 111; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 71, 311, 313, fig. 13b.

Syn.: **Aecidium coruscans** Fries, Physiogr. Sällskap. Aarsb., Lund, 1824, p. 92; Klebahn, Kryptogfl. M. Brandb. Va, 1914, S. 862, Fig. X2 (S. 856).

Spermagonia mainly at the tip of leaves in different areas, sunken into their mesophile, not covered by the epidermis but apparently breaking through the epidermal cells, globoid, about 120 μ across, orange-yellow to brownish.

Aecia developing in the spring from the spruce buds on all young leaves; the infected shoot resembles a small brush since no internodes develop. Aecia on 2—4 facets of the needles, extending sometimes along their entire length, up to 0.5 mm wide, developing under several layers of cells, dehiscing longitudinally, whereby the peridium is soon destroyed; peridia consist of colorless cells lying irregularly over each other; the cells appear twisted, their lateral walls about 3 μ thick, in optical section transversally striated, inner wall verruculose. Aeciospores short- or elongate-ellipsoid, greatly varying in size, 27—46 (52) × 19—32 μ; spore walls colorless, thin, densely and finely verrucose; contents orange-yellow (Figure 82).

FIGURE 82. **Chrysomyxa woroninii** Tranz. on **Picea excelsa** Link:

1 — infected shoot; 2 — aeciospore, × 600. (Orig.)

278 Urediospores probably absent. Uredia occasionally found on leaves of preceding year (on "brooms") were probably of **Chrysomyxa ledi**.

Telia develop on young leaves (emerging in the spring from the buds) of perennial brooms (up to 7 years) distinguished from normal shoots by their vertical orientation and rather numerous, thickly set branchings; the bark of the "broom" branch is rough, whereas that of the uninfected parts of the tuft is smooth. Telia orange-red, small, flat-pulvinate, covering the entire underside of the first leaves growing from the buds, while occupying only limited areas on the following leaves; the lower leaves of the infected shoot remain free of infection; on the upper side of leaves yellow or reddish-yellow spots correspond to the developed telia. Teliospores, 80—90 × 14 μ, in short rows, each comprising a few spores.

Basidiospores globoid-ovoid, 11—13 × 8—13 μ, with orange-reddish contents.

Aecia on spruce, teliospores on wild rosemary. Aecia (**Aecidium coruscans** Fr.) on spruce in the USSR, Scandinavia, and Finland. To the same species or a closely related one is referred the specimen on **Picea likiangensis** from Szechwan (southwestern province of China) (Kryptog. exs. editae a Mus. Hist. Nat. Vind. No. 3006). Teliospores on **Ledum palustre** L., in the USSR, Finland, and Scandinavia.

General distribution: Europe, Siberia.

On **Picea excelsa** Link. — EUROPEAN PART: Kar.-Lap. (Murmansk Region; Karelian ASSR), Lad.-Ilm. (Leningrad Region: Levashevo), Balt. (Estonian SSR; Latvian SSR: Tilsen, Niderbartau near Liepaja).

On **Picea obovata** Ldb. — ARCTIC: Arc. Sib. (basin of the Ob River in the Arctic Urals); W SIBERIA: Ob (Katanga River in the Narym Subregion, Eniseisk, Krasnoyarsk), Lena-Kol. (Irkutsk Region: Nizhnyaya [Lower] Tunguska River; Yakut ASSR; near Yakutsk), Ang.-Say. (Listvennichnoe, on Lake Baikal).

On **Ledum palustre** L. — EUROPEAN PART: Kar.-Lap. (Murmansk Region), Lad.-Ilm. (Leningrad Region: Levashevo, Staraya Petergof, Borok on the Shelon River), Balt. (Estonian SSR: Saare I.; Latvian SSR: Kemeri); FAR EAST: Kamch.

The connection between the aecia on spruce and the teliospores on wild rosemary was not experimentally proved, but the observations in nature recorded by Tranzschel (Tr. Bot. Muz. Akad. Nauk, II, 1904 (1905), pp. 23—27) fully justify the assumption that such a connection exists. On
279 spruce experimentally infected by Liro with teliospores of **Chrysomyxa woroninii** (Acta Soc. pro Fauna et Flora Fennica, XXIX, 7, 1907, pp. 9—21) aecia (**Aecidium corruscans**) appeared in the following spring, but also **Aecidium abietinum** (= **Chrysomyxa ledi**) developed in the first summer; Liro maintained that **Aecidium coruscans** and **Chrysomyxa woroninii** are overwintering forms of **Chrysomyxa ledi**. However, the difference in aecial structure and spore size between **Aecidium coruscans** and **A. abietinum** had been earlier reported by Rees (Abhandl. Naturf. Ges. Halle, XI, 1870, p. 110) and Klebahn (l. c.).

On Rhododendron

5. **Chrysomyxa komarovii** Tranz., Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 313.

Aeciospores and urediospores unknown.

Telia hypophyllous, spreading over large areas on all young leaves, often confluent. Teliospores in chains, about 75μ long (Figure 83).

On **Rhododendron dahuricum** L. only teliospores are known. The type was collected by V. L. Komarov in North Korea (Jacz., Kom. et Tranz. Fungi Rossiae exs. No. 324). This species, though very similar to **Chrysomyxa woroninii** Tranz., is unlikely to be identical with it, since the host belongs to another genus. The telia stage elicits the formation of dense "brooms"; telia are like those of **C. woroninii**. It is possible that the aecia of the latter, mentioned in Listvennichnoe (Irkutsk Region) belong to **C. komarovii**. Only experimental infection of **Ledum** and **Rhododendron** with the aeciospores of the fungus (which is rather a difficult task), will clarify the difference between these fungi.

General distribution: East Siberia.

On **Rhododendron dahuricum** L. — E SIBERIA: Ang.-Say. (Buryat-Mongol ASSR, on the eastern shores of Lake Baikal at the mouth of the Selenga River) Dau. (Buryat-Mongol ASSR; Kyakhta District).

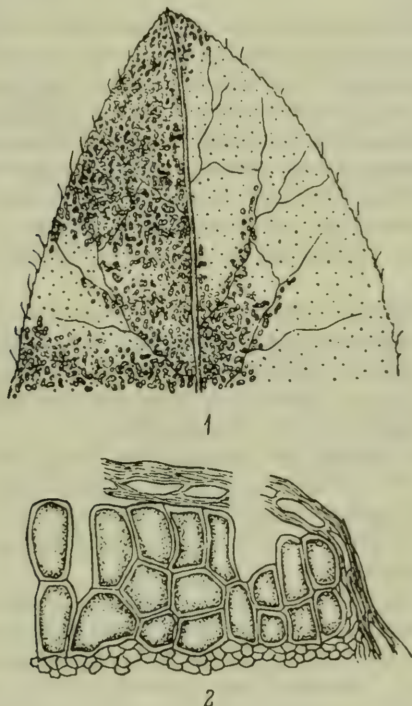


FIGURE 83. Chrysomyxa komarovii Tranz. on Rhododendron dahuricum L.:

1 — infected leaf, × 5; 2 — section through cushion of teliospores, × 600. (Orig.)

On Picea, Pirola

6. **Chrysomyxa pirolae** (DC) Rostr., Bot. Centrbl. V, 1881, S.126; Sacc., Sylloge, VII, 1888, p.761; Fischer, Ured. Schweiz, 1904, S.429; Hariot, Uréd., 1908, p.282; Liro, Ured. Fenn., 1908, p.456; Migula, Kryptog.-Fl. Deutschl. III, 1, 1910, S.457; Grove, Brit. Rust Fungi, 1913, p.312, fig.236,237; Klebahn, Kryptogfl. M. Brandb. Va, 1914, S.713, Fig.K4 (I—IV) (p.722); Trotter, Fl. Ital. Crypt. Ured., 1914, p.358; Syd., Monogr. Ured. III, 1915, p.516; Fragoso, Fl. Iber. Ured. II, 1925, p.293;
280 Arth., Manual Rusts U.S. a. Canada, 1934, p.31, fig.43; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p.69,71,310.

Syn.: **Chrysomyxa pirolatum** (Körn.) Winter in Rabenhorst's Kryptog. Fl. I, 1881, S.250.

Aecidium conorum-piceae Rees, Abhandl. Naturf. Ges. Halle, XI, 1670, S. 102, Taf. II, Fig. 1—4; Fischer, Ured. Schweiz, 1904, S. 525, Fig. 327; Hariot, Uréd., 1908, p. 300; Klebahn, Kryptogfl. M. Brandb. Va, 1914, S. 861, Fig. X I (S. 856).

Melampsoropsis pirolae Arth., N. Amer. Fl. VII, 1907, p. 118; 1925, p. 688; 1927, p. 819.

Spermagonia on the outward side of scales of the spruce cones, subepidermal, numerous, flat, up to 1 mm wide, inconspicuous.

Aecia on the outer side of all scales, except the upper ones of the spruce cones, subepidermal and under 1—3 cell-layers, large, about 4—6 mm across, slightly convex; peridia consist of colorless verrucose cells irregularly overlapping; aecia rupture irregularly, whereupon parts of peridia together with the covering tissue of the scales are shed, exposing the orange-red aeciospores. Aeciospores ellipsoid, $25-36 \times 20-30\mu$; walls colorless, $4-5\mu$ thick, densely covered with large warts, $3-4\mu$ across; contents orange-red.

Uredia appear in spring and summer on last year's leaves, usually covering their underside almost completely, uniformly, and rather densely; round, pulverulent. Urediospores ellipsoid or oblong, $20-30 \times 16-23\mu$; walls colorless, up to 2 mm thick, coarsely verrucose; warts $1.5-2.0\mu$ across; contents orange-yellow (Figure 84).

Telia appear in the spring on leaves from last year, uniformly and rather thickly set, usually hypophyllous, round or irregularly confluent, waxy, red, appearing after germination as if strewn with basidiospores. Teliospores in a series, $100-120\mu$ long, $7-10\mu$ wide; walls smooth, thin.

Basidiospores globoid.

On the cones infected in May aecia mature in July and August. Uredia and telia develop in spring and summer on overwintered **Pirola** leaves (but not on species of the subgenera **Moneses** and **Ramischia**, parasitized by the following species); leaves of the current year do not bear sporophores.

General distribution: Europe, Asia, North America.

On **Picea excelsa** Link — EUROPEAN PART: Kar.-Lap. (Karelian ASSR), Lad.-Ilm. (Leningrad Region: Levashevo).

On **Picea obovata** Ledeb. — EUROPEAN PART: Dv.-Pech. (Pustozernaya tundra on the Pechora), Urals (Zlatoust); FAR EAST: Dau. (former Nerchinsk Subregion).

On **Pirola minor** L. — EUROPEAN PART: Kar.-Lap. (Murmansk Region; Karelian ASSR), Lad.-Ilm. (Leningrad Region, Kalinin Region), U.V. (Moscow Region), V.-Kama (Kirov Region); CAUCASUS: W Transc. (Georgian SSR: Svanetiya); FAR EAST: Sakh. (Sakhalin I.).

281 On **Pirola rotundifolia** L. — EUROPEAN PART: Kar.-Lap., Lad.-Ilm., Balt., U.V., U.Dnp., V.-Kama; W SIBERIA: Ob; E SIBERIA: Yenis. (Turukhansk), Ang.-Say. (Irkutsk); CENTRAL ASIA: Pam.-Al. (Tadzhik SSR: Iskanderkul').

On **Pirola incarnata** Fisch. (= **P. rotundifolia** var. incarnata DC) — ARCTIC: An.; E SIBERIA: Ang.-Say. (Minusinsk); FAR EAST: Ze.-Bu.

In the USSR the fungus may occur also on **Pirola chlorantha** Sw.

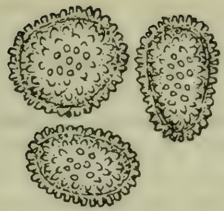


FIGURE 84. **Chrysomyxa pirolae** (DC) Rostr. on **Pirola rotundifolia** L. Urediospores, × 600. (Orig.)

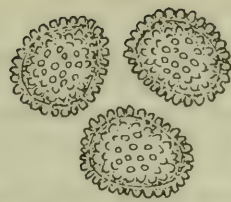


FIGURE 85. **Chrysomyxa ramischiae** Lagerh. on **Pirola secunda** L. Uredio-spores, × 600. (Orig.)

On Pirola

7. **Chrysomyxa ramischiae** Lagerh., Svensk Bot. Tidskrift, III, 1909, p. 26, fig. 1, 3; Sacc., Sylloge, XXI, 1912, p. 717; Klebahn, Kryptogfl. M. Brandb. Va, 1914, S. 715; Syd., Monogr. Ured. III, 1915, p. 518; Ulbrich, Notizbl. Bot. Gart. u. Museum Berlin-Dahlem, XI, 1931, S. 254; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 310.

Syn.: **Chrysomyxa pirolae** pr. p. auct.

Spermagonia and aecia unknown, probably undistinguishable from those of **Chrysomyxa pirolae** (DC) Rostr.

Uredio- and teliospores when microscopically examined indistinguishable from those of **Chrysomyxa pirolae**. On overwintered last year's leaves small uredia and telia are rather thickly set, hypophyllous. On leaves of current year larger uredia develop in summer, less crowded on the leaf surface (Figure 85).

On **Pirola (Ramischia) secunda** L. in Europe, Asia, and North America; in North America apparently also on **P. (Moneses) uniflora** L. and **Moneses reticulata**.

On **Pirola (Ramischia) secunda** L. (incl. **P. obtusata** Turcz.) — EUROPEAN PART: Kar.-Lap., Lad.-Ilm., Balt.; W SIBERIA: Ob (Tobol'sk); FAR EAST: Kamch.

On **Pirola uniflora** L. — EUROPEAN PART: U. Dns. (W Ukraine: Lvov Region (according to Namysłowski under the name **C. pirolae**)).

On Picea, Ledum

8. **Chrysomyxa ledi** (Alb. et Schw.) De Bary, Bot. Ztschr., XXXVII, 1879, S. 809, Taf. 10, Fig. 7, 8; Sacc., Sylloge, VII, 1888, p. 760; Liro, Ured. Fenn., 1908, p. 459; Migula, Kryptog.-Fl. Deutschl. III, 1, 1910, S. 457; Klebahn, Kryptogfl. M. Brandb. Va, 1914, S. 710, Fig. K2 (I—III) (S. 692); Syd., Monogr. Ured. III, 1915, p. 504; Arth., Manual Rusts U.S. a. Canada, 1934, p. 34, fig. 48; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 56, 69, 313.

Syn.: **Aecidium abietinum** Alb. et Schw., Consp. fung. Nisk., 1805, p. 120.

Uredo ledi Alb. et Schw., Consp. fung. Nisk., 1805, p. 125.

Caeoma ledi Link, Willd. Sp. pl. VI, 2, 1925, p. 15.

Melampsoropsis ledi Arth., Résult. scient. Congr. bot. Vienne, 1905, 1906, p.338.

M. **abietina** (Alb. et Schw.) Arth., N. Amer. Fl. VII, 1907, p.119; 1925, p.690; 1927, p.814, 820.

Biol. Klebahn, Ztschr. Pflanzenkr. XII, 1902, S.141; Liro, Acta Soc. fauna et flora Fennica, XXIX, 7, 1907, p.9—21; Fraser in Mycologia, III, 1911, p.69; IV, 1912, p.178; Arth., Mycologia, IV, 1912, p.26.

282 Spermagonia amphigenous, globoid, about 120μ in diameter, orange-yellow, later dark red.

Aecia hypophyllous, in 2 rows on yellow patches, oblong, constricted at the sides; peridia rupturing irregularly lengthwise, white; peridial cells adjoin each other (with the facets), not overlapping at the borders; walls thick, 3—4μ; in longitudinal section outer wall thin, smooth, concave; inner wall thick. Aeciospores ellipsoid, 19—30 × 15—21μ; walls colorless, 2.0—2.5μ thick, in optical section striated with verrucose planes; contents orange-red.

Uredia on last year's leaves hypophyllous, appearing in spring and summer, single or in groups, occasionally confluent, round, orange-red, with rudimentary peridium at the base. Urediospores ellipsoid or subgloboid, 20—30 × 14—23μ; wall colorless, 1.5—2.5μ thick, verrucose, in section striated; contents orange-red.

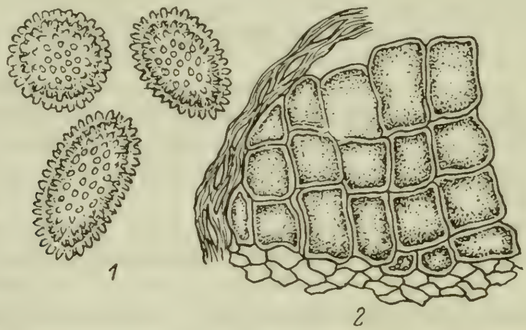


FIGURE 86. **Chrysomyxa ledi** (Alb. et Schw.) de Bary:

1 — aeciospores on **Picea excelsa** Link.; 2 — section through cushion of teliospores, × 120, on **Ledum** sp. (Orig.)

Telia appear in the spring, hypophyllous, flat, blood-red, later orange-red. Teliospores in series, 70—90μ long, 5—6-celled, 13—20 × 10—15μ, readily separating; walls colorless, thin, smooth; contents orange-red.

Aecia develop in July and August on individual leaves of spruce species. Uredia are encountered on leaves of **Ledum** species in the beginning of summer, telia — in the spring. The leaves bearing the sori are sometimes shed in the summer, in which case the fungus cannot always be found at the end of summer (Figure 86).

The fungus is spread in northern parts of Europe, Asia, and America, apparently, throughout the **Ledum** range.

On **Picea excelsa** Link — EUROPEAN PART: Kar.-Lap. (Karelian ASSR), Dv.-Pech. (Arkhangel'sk Region), Balt. (Estonian SSR, Latvian SSR, Lithuanian SSR), Lad.-Ilm. (Leningrad Region, Kalinin Region), U. V. (Moscow Region, Ivanovo Region), V.-Kama (Yaroslavl', Kirov, and Gorkii regions, Tatar ASSR), U. Dnp. (Smolensk Region, Belorussian SSR), M. Dnp. (Kursk).

On **Picea fennica** Regel — EUROPEAN PART: Kar.-Lap. (Murmansk Region: Khibiny Mts.).

On **Picea obovata** Ldb. — EUROPEAN PART: Dv.-Pech. (Komi ASSR: Usa River), Urals; W SIBERIA: Ob (Sverdlovsk, Tomsk): E SIBERIA: Yenis. (Krasnoyarsk Territory: Podkamenno-Tungusskii settlement),
283 Ang.-Say. (Podvolochnaya village in former Balagansk County).

On **Ledum palustre** L. — EUROPEAN PART: Kar.-Lap. (Murmansk Region, Karelian ASSR), Dv.-Pech. (Arkhangel'sk Region), Balt. (Estonian SSR, Lithuanian SSR), Lad.-Ilm. (Leningrad Region, Kalinin Region), U. V. (Moscow Region), U. Dnp. (Belorussian SSR: Bialowieza Forest); W SIBERIA: Ob (Pokrovskoe winter quarters in Northern Urals).

De Bary (l. c., 1879, p. 802) obtained aecia on spruce experimentally infected with teliospores from **Ledum**; Klebahn obtained uredia on **Ledum** experimentally infected with aecia from spruce. Liro maintained that **Chrysomyxa woroninii** and **Aecidium coruscans** represent overwintering forms of **C. ledi** and **A. abietinum**; experimental infections with spores of the two species produced on spruce aecia of **A. abietinum**, while spruce infections with basidiospores of **C. woroninii** produced aecia of **A. coruscans**; however, experimental infections of **Ledum** with aeciospores of **A. coruscans** remained ineffective. In North America, Fraser obtained aecia of **A. abietinum** on **Picea rubra** experimentally infected with teliospores from **Ledum groenlandicum**. Arthur succeeded in infecting **Picea mariana** with teliospores from the same species of **Ledum**.

9. **Chrysomyxa ledicola** (Peck) Lagerh., Troms Mus. Aarsh. XVI, 1893, p. 119; Sacc., Sylloge, VII, 1888, p. 582; Syd., Monogr. Ured. III, 1915, p. 507; Arth., Manual Rusts U.S. a. Canada, 1934, p. 33, fig. 46; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 313.

Syn.: **Melampsoropsis ledicola** (Peck) Arth., N. Amer. Fl. VII, 1907, p. 119; 1925, p. 689; 1927, p. 820.

Peridermium decolorans Peck, Ann. Rep. N.Y. St. Mus. XXVII, 1893, p. 119.

Spermagonia amphigenous, punctate.

Aecia hypophyllous, with compressed, fragile peridia; peridial cells interlocking, or slightly covering each other. Aeciospores broad-ellipsoid or globoid, very large, $27-55 \times 22-40\mu$; walls colorless, $3-6\mu$ thick, coarsely verrucose.

Uredia epiphyllous on reddish-brown spots, small, pale yellowish or reddish. Urediospores broad-ellipsoid or globoid, $26-36 \times 18-29\mu$; walls colorless, $2.5-3\mu$ thick, densely verrucose (Figure 87).

Telia epiphyllous, flat, minute, initially blood-red. Teliospores prismatic or cubical, $13-18 \times 10-14\mu$, in series $65-80\mu$ long; walls colorless of uniform thickness (1μ).

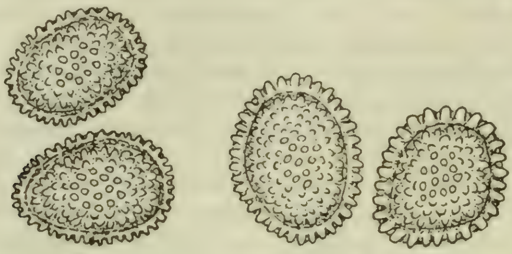
The description given is according to Arthur (1934). The fungus is found on species of Ledum in Kamchatka (on **L. palustre** L. var. decumbens

Ait. = **L. decumbens** (Ait.) Schmall), in the northern islands of Japan (on **L. palustre** L. var. **procumbens** Ait.), and in North America, from Alaska, Yukon, Labrador, and western Greenland southward to the states of Washing-
284 ton, Wisconsin, and New York. In America, the aecia (on **Ledum decumbens** (Ait.) Schmall and **L. groenlandicum** Oeder) have been obtained in culture on **Picea canadensis** (Mill.) Britt. (= **P. alba** Link), and found on five species of **Picea**. As stated by Jørstad (A Study on Kamchatka Uredinales, 1933, p. 31), **Chrysomyxa ledicola** is apparently not necessarily heteroecious, for the fungus ranges in the Arctic regions of North America as well as in Kamchatka, beyond the range of the spruce.

General distribution: northeast Asia, North America, Greenland.

On **Picea** absent from the USSR collection.

On **Ledum decumbens** (Ait.) Schmall — FAR EAST: Kamch.



1 2

FIGURE 87. **Chrysomyxa ledicola** (Peck) Lagerh. :

1 — urediospores on **Ledum** sp.; 2—aeciospores on **Picea** sp., ×600. (Orig.)

On Picea, Rhododendron

10. **Chrysomyxa rhododendri** (DC) de Bary, Bot. Ztschr., XXXVII, 1879, S. 809, Taf. X, Fig. 1—6; Sacc., Sylloge, VII, 1888, p. 760; Fischer, Ured. Schweiz, 1904, S. 426; Hariot, Uréd., 1908, p. 283, fig. 45; Migula, Kryptog.-Fl. Deutschl. III, 1, 1910, S. 456, Taf. IX J, Fig. 2; Grove, Brit. Rust Fungi, 1913, p. 384; Klebahn, Kryptogfl. M. Brandb. Va, 1914, S. 708, Fig. K1 (I—III) (S. 692); Trotter, Fl. Ital. Crypt. Ured., 1914, p. 359, fig. 11, 25, 26, 87; Syd., Monogr. Ured. III, 1915, p. 508, tab. XXIII, fig. 168; Fragoso, Fl. Iber. Ured. II, 1925, p. 291, fig. 142, 143; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 69, 70, 310.

Syn.: **Aecidium abietinum** auct. pr. p.

Spermagonia amphigenous, globoid, yellow, later brown.

Aecia hypophyllous, on lateral, yellowed zones of the leaves, longitudinally oblong, compressed at the sides; peridia irregularly torn, white; peridial cells with slightly overlapping borders, their lateral walls thinner than in **Chrysomyxa ledi**, 2 — 3 μ, in longitudinal section the outer wall concave, thin, smooth; the inner wall convex, thicker, crosswise striated (verrucose surface), slanting, thinner, below. Aeciospores ellipsoid, 20 — 40 × 14 — 22 μ; walls 1 — 2 μ thick, colorless, verrucose; contents orange-red.

Uredia mostly hypophyllous on reddish or brown spots, small, round or oblong, scattered or in groups, orange-red. Urediospores ellipsoid or ovoid, $17-28 \times 15-22 \mu$; walls colorless, $1-2 \mu$ thick, verrucose, in section striated; contents orange-red (Figure 88).

Telia hypophyllous, on overwintered leaves, mostly in groups, reddish-brown. Teliospores in rows up to 130μ long, 4- to 6-celled, $20-30 \times 10-14 \mu$; walls colorless, thin, smooth; contents orange-red.

Aecia appear on individual leaves of **Picea** at the end of summer. Uredia in summer, telia in spring on overwintered leaves of **Rhododendron** in mountainous sites in western Europe. The fungus is occasionally introduced in gardens together with the host; thus, it was found in the uredial stage on **Rhododendron hirsutum** L., in 1892, in a garden at Levashevo near Leningrad; to the same fungus is referred the fungus on **Rhododendron dahuricum** L. found in the Altai, the Sayans, the Far Eastern Territory, and Japan.

FIGURE 88. Chrysomyxa rhododendri (DC) de Bary on Rhododendron kotschyi Simk. Urediospores, ×600. (Orig.)

285 General distribution: Europe, Asia.

On **Picea excelsa** L. — EUROPEAN PART: W Ukraine.

On **Picea obovata** Ldb. — E SIBERIA: Ang.-Say., Ze.-Bu. (**C. rhododendri** (DC) de Bary (?)).

On **Rhododendron hirsutum** L. (cult.) — EUROPEAN PART: Lad.-Ilm. (Leningrad Region: Levashevo (II)), (in W Europe also on **R. ferrugineum** L.).

On **Rhododendron kotschyi** Simk. — EUROPEAN PART: W Ukraine.

On **Rhododendron dahuricum** L. (incl. **R. mucronulatum** Turcz.) — W SIBERIA: Alt.; FAR EAST: Ze.-Bu., Uss.

11. **Chrysomyxa succinea** (Sacc.) Tranz., Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 70, 314.

Syn.: **Gloeosporium succineum** Sacc., Michelia, II, 6, p. 145; in Thümen, Mycotheca univers. No. 1765 (II and III!).

Chrysomyxa alpina Hirats., Bot. Mag. Tokyo, XLIII, 1929, p. 471.

Spermagonia hypophyllous, globoid, dark red.

Aecia hypophyllous, in 2 rows on yellowed leaves, elongate, laterally compressed; peridia irregularly torn, white; peridial cells slightly overlapping at their borders, lateral walls thin, $2-2.5 \mu$; in longitudinal section outer wall thin, concave or plane, inner wall convex, thicker, coarsely striate transversally, verrucose, wall slanting at bottom. Aeciospores ellipsoid or subgloboid, rarely oblong, $24-40 \times 10-24 \mu$; walls thin, 1μ, colorless, verrucose; contents orange-colored.

Uredia hypophyllous, occasionally on petioles, scattered, rounded, orange-yellow. Urediospores globoid, ellipsoid or oblong, $18-36 \times 14-23 \mu$;
286 walls densely verrucose, colorless; contents orange-yellow (Figure 89).

Telia hypophyllous, eliciting red or brown spots on the upper side of leaves, scattered or in groups, small, expanding into subgloboid or ellipsoid caps, 0.25 — 0.6 mm across, on short pedicels. Teliospores in rows, cylindrical to prismatic, oblong or ovoid, $14-27 \times 7-15 \mu$; walls thin, smooth.

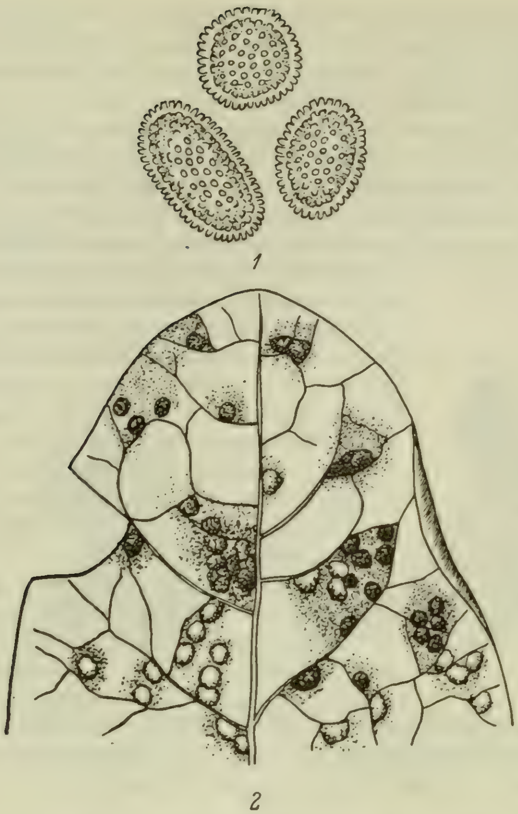


FIGURE 89. Chrysomyxa succinea (Sacc.) Tranz. on Rhododendron aureum Georgi:

1 — urediospores, ×600; 2 — leaf with uredia, ×5. (Orig.)

Uredio- and teliospores on leaves and petioles of **Rhododendron aureum** Georgi, on the bare peaks in the Far East, Kamchatka, and the Kuril Islands. The aecia earlier described on **Picea jezoensis** (Sieb. et Zucc.) Carr. (= **P. ajanensis** Fisch.), collected on the slopes of the Tukuringra Range in the Zeya River basin, are referred to this species with certain doubts; they resemble aecia of **Chrysomyxa rhododendri**.

General distribution: USSR (Far East), Japan.

On **Picea jezoensis** (Sieb. et Zucc.) Carr. (= **P. ajanensis** Fisch.) — FAR EAST: Ze.-Bu.

On **Rhododendron aureum** Georgi — W SIBERIA: Alt.; E SIBERIA: Dau.; FAR EAST: Ze.-Bu., Kamch., Sakh. (Kuril Is.).

On Picea, Chamaedaphne

12. **Chrysomyxa cassandrae** (Peck et Clint.) Tranz., Tranzschel, Tr. SPb. obshch. estestvoisp., Otd. Bot., XXIII, 1893, Protokoly, p. 28;

Sacc., Sylloge, XVII, 1905, p. 397; Liro, Ured. Fenn., 1908, p. 465; Syd., Monogr. Ured. III, 1915, p. 513; Arth., Manual Rusts U.S. a. Canada, 1934, p. 34, fig. 47; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 314.

Syn.: **Melampsoropsis cassandrae** Arth., Résult. scient. Congr. bot. Vienne, 1905, 1906, p. 338; N. Amer. Fl. VII, 1907, p. 119; 1925, p. 689; 1927, p. 820.

Uredo cassandrae Peck et Clint., XXX Report N. Y. St. Museum, 1878, p. 54.

Caeoma cassandrae Gobi, Scripta bot. Horti Univ. Petropol. I, 1886, p. 117.

Peridermium consimile Arth. et Kern. Bull. Torrey Bot. Club, XXXIII, 1906, p. 427.

Biol. Clinton, Ann. Rep. Conn. Agric. Exper. Sta. 31—32, 1908, p. 387; 37, 1924, p. 495; Fraser, Mycologia, 3, 1911, p. 68; 4, 1912, p. 178.

Spermagonia amphigenous, punctate, yellow, later black-brown, subepidermal, almost entirely immersed, 110—115 μ across.

Aecia mostly hypophyllous, in 2 rows on yellowed zones or over the entire frond, laterally compressed; peridia rupture at the top, white, rather delicate; peridial cells slightly overlapping, inner wall thickened, verrucose, transversally striated; outer wall thinner, smooth. Aeciospores broad-ellipsoid or globoid, 24—35 × 16—23 μ; walls colorless, not uniformly thick, 1.5—2.5 μ, densely and finely verruculose.

Uredia hypophyllous, scattered or in groups, orange-red. Urediospores broad-ellipsoid, 18—32 × 16—23 μ; walls colorless, 1.5—2.0 μ thick, densely verrucose; contents orange-red (Figure 90).

287

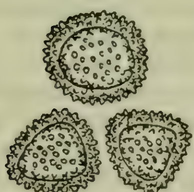


FIGURE 90. Chrysomyxa cassandrae (Peck et Clint.) on Chemaedaphne sp. Urediospores, × 600. (Orig.)

Telia hypophyllous, small and barely visible, red. Teliospores in rows, 60—75 μ long, prismatic, 15—25 × 11—16 μ, with smooth, colorless walls and orange-red contents.

Uredio- and teliospores on leaves of **Chamaedaphne calyculata** (L.) Mönch. (= **Cassandra calyculata** D. Don.). Teliospores rarely recorded.

Distribution in northern Europe (from Denmark to Sweden), northern Asia (as far as Japan) and in North America. In North America aecia on **Picea mariana** (Mill.) B. S. P. (= **P. nigra** Ait.), and apparently on other spruce species. Experimental infections were carried out by Clinton (1908, 1924) and Fraser (1911, 1912).

General distribution: northern Europe, northern Asia, North America.

Aecia not found in the USSR.

On **Chamaedaphne calyculata** (L.) Mönch. (= **Cassandra calyculata** D. Don.) — EUROPEAN PART: Kar.-Lap. (Karelian ASSR; Murmansk Region: Tetrinozh), Dv.-Pech. (Onega River, Shenkursk), Lad.-Ilm., U. V., (Moscow Region: Mozhaisk). U. Dnp. (Smolensk), V.-Kama, Balt.; W SIBERIA: Ob (Krasnoufimsk, Tobol'sk, Tomsk); E SIBERIA: Lena-Kol., Ang.-Say. (Minusinsk, Irkutsk); FAR EAST: Kamch., Sakh.

On Empetrum

13. **Chrysomyxa empetri** (Pers.) Schroet., Kryptog. Fl. Schles. III, 1, 1887, S. 372; Liro, Ured. Fenn., 1908, p. 454; Grove, Brit. Rust Fungi, 1913, p. 311, fig. 235; Trotter, Fl. Ital. Crypt. Ured., 1914, p. 360; Syd., Monogr. III, 1915, p. 515; Fragoso, Fl. Iber. Ured. II, 1925, p. 295; Arth., Manual Rusts U. S. a. Canada, 1934, p. 31, fig. 41; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 36, 273.

Syn.: **Chrysomyxa empetri** (Pers.) Rostr., Meddel. om Grönland, III, 1888, p. 536. Sacc., Sylloge, VII, 1888, p. 762; Fischer, Ured. Schweiz, 1904, S. 557; Hariot, Uréd., 1908, p. 282; Migula, Kryptog.-Fl. Deutschl. III, 1, 1910, S. 457; Klebahn, Kryptogfl. M. Brandb. Va, 1814, S. 716, Fig. K6 (S. 722).

Melampsoropsis empetri Arth., Résult. scient. Congr. bot. Vienne, 1905, 1906, p. 338; N. Amer. Fl. VII, 1907, p. 118; 1925, p. 688; 1927, p. 819.

Uredo empetri Pers. ex DC, Fl. France, VI, 1815, p. 87.

Biol. Faull, Journ. Arn. Arb. XVIII, 1937, pp. 141—148, fig. 1, tab. 202, 203.

Spermagonia amphigenous, uniseriate, conspicuous, yellowish, later reddish-brown, subepidermal, immersed, slightly protruding, 135—162 μ across, 108—135 μ wide, on an average, 145 × 125 μ. Spermatia subgloboid to ellipsoid, 5.5—10.0 × 5—7 μ, exuded in a colorless, sticky liquid.

Aecia on leaves of current year, amphigenous, uniseriate on yellowish areas of the tissue, elliptical to subcircular in transverse section, 0.5—1.5 mm wide, 0.5—2.0 mm high, yellow; peridia colorless, rupturing at apex; peridial cells polygonal, vertically elongate, not tessellate or slightly tessellate—overlapping, outer walls smooth, about 1 μ thick, outer walls rather coarsely verrucose, 4—6 μ thick. Aeciospores ellipsoid or ovoid, rarely subgloboid, 27—54 × 22—32 μ (on an
288 average, 42 × 27 μ); walls densely and rather coarsely verrucose, warts evanescent at maturation of spores.

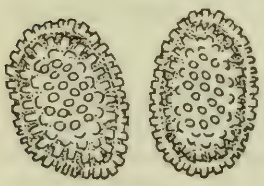


FIGURE 91. Chrysomyxa empetri (Pers.) Schroet. on Empetrum nigrum L. Urediospores, × 600. (Orig.)

Uredia on the recurved underside of the leaves (morphologically epiphyllous) circular or oblong, initially covered by the swollen epidermis, later exposed, orange-red; peridium conspicuous, contiguous with the epidermis together with which it ruptures at the maturation of uredia. Urediospores ellipsoid, ovoid, or subgloboid, 27—48 × 21—28 μ; walls colorless, 1.5—2.0 μ thick, densely and rather coarsely verrucose; contents orange-yellow (Figure 91).

Telia appear in the spring or beginning of summer, morphologically epiphyllous on the recurved side of the overwintered leaves, pulvinate, waxy, subepidermal; their surface yellow or straw-colored, subgloboid or mostly elongate, 0.5—3.0 mm long; the covering epidermis extensively torn at maturation. Teliospores with yellow contents, catenulate, 3—6 in a chain, smooth, thin-walled, 19—24 × 18—21 μ.

Basidia pale yellow, slightly curved or bow-shaped, 7—8 μ across, up to 65 μ long. Basidiospores with yellow contents, subgloboid or broad-ellipsoid, 10—15 μ (usually about 12 μ) across.

On species of **Empetrum**. Teliospores seldom encountered. Rostrup found them on specimens from Greenland, Lagerheim and Blitt in specimens from Norway. In June 1935 Faull found them in abundance in two places in Canada; he also recorded them in specimens from New Hampshire. The uredial stage is widespread in Europe, Asia (as far as Japan), and in North America on **Empetrum nigrum** L. In northern Europe on **E. hermaphroditum** (Lange) Hagerup, in North America, also on **E. atropurpureum** Fern. et Wieg., and on **E. eamesii** Fern. et Wieg., whereas in South America (on Falkland Islands) on **E. rubrum** Vahl (Arvidsson, Bot. Not., 1936, p. 479).

General distribution: Europe, Asia (as far as Japan), America.

On **Empetrum nigrum** L. (urediospores) — EUROPEAN PART: Kar.-Lap., Lad.-Ilm., Dv.-Pech., Balt., U. Dns.; E SIBERIA: Lena-Kol., Ang.-Say.

Teliospores sown on **Picea glauca** Voss and **P. rubens** Sorg. gave rise to a luxuriant growth of aecia within 6 to 8 weeks. In some experiments aeciospores sown in September on **Empetrum nigrum** L. produced uredia in October-November, while in the majority of cases telia were produced at the end of April in the following year (Faull, l. c.).

On Arctostaphylos

14. **Chrysomyxa arctostaphyli** Diet., Bot. Gaz. XIX, 1894, p. 303; Sacc., Sylloge, XI, 1895, p. 209; Syd., Monogr. Ured. III, 1905, p. 513; Arth., N. Amer. Fl. VII, 1925, p. 691; 1927, p. 814, 820; Arth., Manual Rusts U. S. a. Canada, 1934, p. 36, fig. 51; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 313.

Syn.: **Melampsoropsis arctostaphyli** Arth., Résult. scient. Congr. bot. Vienne, 1905, 1906, p. 338; N. Amer. Fl. VII, 1907, p. 120; 1927, p. 820.

Spermagonia, aecia, and uredia unknown.

289 Telia hypophyllous, gathered in circular groups on reddish-brown spots, flat, circular, 0.3 — 0.8 mm in diameter, waxy, surrounded by torn epidermis. Teliospores in rows, $100-170\,\mu$ long, oblong, $25-50 \times 13-17\,\mu$, smooth.

Basidiospores globoid, $6-8\,\mu$ across; contents golden-yellow.

On **Arctostaphylos uva-ursi** (L.) Spreng. The fungus is known in North America from Alaska and southern Yukon southeastward to the northern part of Wisconsin and the central part of Utah. It may occur in the northwestern USSR.

Occurrence of the species only in the teliospore stage on representatives of the family **Ericaceae** is rather surprising. We would rather have expected the development of aecia in its cycle, as in **Chrysomyxa woroninii** Tranz. on **Ledum**, and **C. expansa** Diet. on **Rhododendron**, in Japan. It is regrettable that the specimen in the herbarium of the Botanical Institute of AN SSSR is in a rather bad condition and makes impossible a clear determination of the fungus.

12. Genus PUCCINIOSTELE Tranz. et Kom.

Tranzschel and Komarov, Tr. SPb, obshch. estestvoispyt., XXX, 1, 1899, p. 138; Syd., Monogr. Ured. III, 1915, p. 325; Cummins a. Thirumalachar, Mycologia, XLV, 4, 1953, p. 572 — 578.

Spermagonia flattened, epiphyllous, subepidermal. Aecia caeomoid; aeciospores angular-ellipsoid, verrucose or echinulate, in chains. Uredia with peridium or surrounded by paraphyses; urediospores develop in chains or single, verrucose or echinulate. Teliospores of two kinds: 1) developing in aecia on hyphae that have earlier produced the aeciospore chains, 4-celled, smooth, in chains; 2) developing in fall in telia not connected with the aecia, small, orange-red, teliospores in chains or columnar, unicellular, rarely 2-celled, smooth, 2 to 12 in a chain. Germination of spores has not been recorded and the role of the primary teliospores in the life cycle of the fungus is unknown.

On species of **Astilbe** and **Ampelopsis cantoniensis** (China). Five species are known: one in the USSR (Far East), and the remaining four in China, Japan, India, and the Philippine Islands.

On Saxifragaceae

1. **Pucciniostele mandschurica** Diet., Ann. mycol. II, 1904, p. 21; Syd., Monogr. Ured. III, 1915, p. 328; Kursanov, Tseshinskaya Klyushnikova, Byull. Mosk. Obshch. Ispyt. Prir., Otd. Biol. XLV, 2, 1936, p. 76; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 212.

Syn.: **Pucciniostele Clarkiana** Kom. et Tranz. (non Dietel), Komarov and Tranzschel, Tr. SPb. Obshch. Estestvoispyt. XXX, 1, 1899, Protok. Zased., 1—2, p. 138; Jaczewski, Komarov, Tranzschel, Fungi Rossiae exs. No. 279—280, 1899; Komarov, Hedwigia, XXXIX, 1900, S. 121; Sacc., Sylloge, XVI, 1902, p. 321, pr. p.

Klastopsora Komarovii Diet., Ann. mycol. II, 1904, p. 24; V, 1907, p. 74; VIII, 1910, p. 312; Sacc., Sylloge, XVII, 1905, p. 264.

Spermagonia not described.

290 Aecia (caeoma) orange-yellow causing thickening of petioles and veins. Aeciospores relatively large, about 25μ in diameter, coarsely verrucose.

Urediospores unknown.

Later, on the same hyphae on which the aeciospore chains arose, develop the primary chains of teliospores, each of which is 4-celled, appearing like two fused teliospores of **Puccinia**; after the onset of teliospore development the telia acquire a slightly brownish tint. In the second half of the summer or in fall secondary teliospores appear on the leaves (**Klastopsora komarovii** Diet.) in the form of minute orange-red, shiny, convex heaps resembling teliospores of **Coleosporium**; the telia consist of cylindrical, 5- to 12-celled columns, fused at first, later disintegrating. Spore germination has not yet been recorded.

Experimental verification of the connection between the different fructification forms was attempted by V. G. Tranzschel (1939), who sowed aeciospores in the open; the results were so insignificant (some sori of "**Klastospora**" were obtained) that the experiment should be repeated. A closely related species, **Pucciniostele clarkiana** (Barcl.) Diet., occurs on species of **Astilbe** in China, India, and Japan. A fungus closely resembling **Pucciniostele** in the external appearance of the sori and the sculpture of spores was found on **Sedum telephium**, near Voroshilov. It is possible that this is a sixth species of **Pucciniostele**, or that **P. mandschurica** infects **Sedum** (see **Caeoma sedi**, Tranzschel, l. c., p. 208).

On species of **Astilbe** in the USSR (Far East), China, Korea, and Japan.

On **Astilbe chinensis** (Max.) Franch. et Sav. — FAR EAST: Uss. (Maritime Territory).

13. Genus CEROTELIUM Arth.

Arth., N. Amer. Fl. VII, 1925, p. 606; Manual Rusts U.S. a. Canada, 1934, p. 61.

Spermagonia flat, without paraphyses. Aecia cupulate with compact peridium; aeciospores catenulate, globoid, or ellipsoid, verrucose. Uredia circular, with delicate peridium, with or without paraphyses; urediospores produced singly, ellipsoid, echinulate. Telia frequently arising from the base of uredia, waxy, loose after maturation, slightly pulverulent, whitish; teliospores in chains, 2- to 8-celled, oblong or broad-ellipsoid, cuboid; walls thin, smooth, colorless.

Heteroecious species scarcely known. On **Urticaceae** and other families in warm climates; 20 species known. In the USSR on species of **Ficus** (Caucasus).

On Moraceae

1. **Cerotelium fici** (Cast.) Arth., Bull. Torrey Bot. Club, XLIV, 1917, p. 509; N. Amer. Fl. VII, 1925, p. 696; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 162.

Syn.: **Uredo fici** Cast. apud Desm. Plant. Crypt. (Fasc. 34), No. 1662, 1848; Sacc., Sylloge, VII, 1888, p. 847.

U. citri Cooke, Grevillea, VI, 1878, p. 138.

U. moricola P. Henn., Hedwigia, XLI, 1902, S. 140; Sacc., Sylloge, XV, 1, 1905, p. 451.

291 **Physopella fici** Arth., Résult. scient. Congr. intern. bot. Vienne, 1905, 1906, p. 338; N. Amer. Fl. VII, 1907, p. 103.

Kuehneola fici Butl., Ann. mycol. XII, 1914, p. 76; Fragoso, Fl. Iber. Ured. II, 1925, p. 163, fig. 81.

Spermagonia and aecia unknown.

Uredia hypophyllous, small pustular, rupturing centrally at the torn epidermis, reddish-brown, surrounded (though not always) by flexuous paraphyses. Urediospores broad-ellipsoid or obovoid-globoid, with yellowish echinulate walls, $15-22 \times 18-30\mu$ (according to Sydow $14-20 \times 18-28\mu$); walls $1.0-1.5\mu$ thick (Figure 92).

FIGURE 92. **Cerotelium fici** (Cast.) Arth. Urediospores on **Ficus carica** L. (After Arthur)

Telia hypophyllous scattered, minute, slightly pulverulent, white. Teliospores in chains of 2 to 7, angularly rounded, broad-ellipsoid or oblong, smooth, $10-13 \times 15-22\mu$, with colorless wall.

On species of **Ficus** and **Morus** and on **Maclura aurantiaca** Nutt., in tropical and subtropical regions all over the globe. Usually in the uredial stage. Teliospores were reported once from northern India by Butler. In the USSR (Caucasus: Batumi) on **Ficus elastica** Roxb. (in hothouse), **F. macrophylla** Desf., and **F. carica** L.

14. Genus BAEODROMUS Arth.

Arth., Ann. mycol. III, 1905, p. 19; Manual Rusts U. S. a. Canada, 1934, p. 62; Syd., Monogr. Ured. III, 1915, p. 548.

Spermagonia globoid or flask-shaped, with paraphyses. Aecia and urediospores unknown. Telia similar to aecia, without paraphyses, minute, opening from under the epidermis; teliospores in chains of 4 — 8, unicellular, celled, ellipsoid, pulverulent at the surface of the sorus, with colorless or brownish smooth spore walls, germinating soon after maturation.

On species of **Eupatorium** and **Senecio** in America. Five species are known, of which one in the USSR.

On Urticaceae

1. Baeodromus (?) urticae Tranz. ad interim, Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 162 — 163.

Spermagonia, aecia, and uredia unknown.

Telia hypophyllous, minute ($70\,\mu$), brown, naked, in small, nonconfluent groups ($300 - 400\,\mu$). Each telium consists of rows of brownish ellipsoid cells, 5 in a row.

According to Tranzschel the fungus is scarcely discernible and does not cause discoloration on leaves. Scantiness of the material prevents more detailed description of the fungus.

On **Urtica laetevirens** Max. — FAR EAST: Maritime Territory, in the mountains above the Kharitonovka River (Maikhe River basin) collected by Tranzschel on 14 September, 1929; [former] Ussuri Region, at the Krivoi spring (Suputinka River basin), collected by V. Komarov on 6 August, 1931.

292 ## IV. Subfamily COLEOSPORIEAE

Aecia with bladder-shaped or cupulate peridia. Urediospores single or in chains. Teliospores in waxy sori, cylindrical, germinating soon after maturation with the formation of 4-celled endospores (inner basidia), each cell producing a sterigma bearing a basidiospore. Basidiospores large, ellipsoid or prismatic, occasionally not quite equilateral, bearing at the base a lateral, colorless beak (in **Coleosporium**).

Key to Genera of Subfamily Coleosporieae

I. Urediospores in chains; teliospore wall greatly thickened at apex . . . . 15. Coleosporium Lév. (p. 391)

II. Urediospores single; teliospore wall without apical thickening . . . . 16. Ochropsora Diet.(p. 428)

15. Genus COLEOSPORIUM Lév.

Lév., Ann. sci. natur. III, ser. VIII, 1847, p. 373; Syd., Monogr. Ured. III, 1915, p. 595; Klebahn, Kryptogfl. M. Brandb. Va, 1914, S. 730; Arth., Manual Rusts U. S. a. Canada, 1934, p. 36.

Spermagonia develop under the epidermis, flat-conical, pigmented. Aecia with bladder-shaped, colorless, irregularly dehiscing peridia; on pine needles. Aeciospores in chains; walls colorless, with striated (verrucose) structure; contents orange-colored. Uredia naked, without peridia, orange-colored. Urediospores develop in chains which are easily broken; similar to aeciospores. Telia waxy, compact, colored by red or orange pigment. Teliospores cylindrical, sessile, with apical thickenings, initially unicellular, producing upon germination a 4-celled basidium which germinates as soon as formed, at the end of summer. Basidiospores on elongate sterigmata, large, ellipsoid or slightly unequal-sided with orange-colored contents, at the base with a colorless lateral beak.

Spermagonia and aecia on previous year's needles of species of genus **Pinus**, at the onset of summer; one species (Mexican) monoecious, with all stages on **Compositae**. Uredio- and teliospores on plants of different families, mainly **Compositae**; in Eurasia and Africa many species on **Ranunculaceae**.

About 80 species have been described, morphologically similar to each other. In the USSR there are 28 species.

Some species of **Coleosporium** are known to attack plants other than their usual hosts (see **Coleosporium vagans**, p. 418; Klebahn, 1914, p. 752; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 333). The factors responsible for this occurrence and its incidence among the individual species are not clear.

293 Key to Species of Coleosporium

I. Only teliospores on needles of **Pinus** . . .1. C. pinicola (Arth.) Jackson.

II. Aecia, if such are known, on needles of **Pinus**, uredio- and teliospores on **Angiospermae**.

A. On family **Ranunculaceae**.

1. On species of **Acinitum** . . . . 2. C. aconiti Thüm.
2. On species of **Cimicifuga** . . . . . . 3. C. cimicifugatum Thüm.
3. On species of **Actea** . . . . 4. C. actaeae Karst.
4. On species of **Delphinium** . . . . 5. C. martianoffianum (Thüm.) Syd.
5. On species of **Pulsatilla** . . . . 6. C. pulsatillae (Strauss) Lév.
6. On species of **Clematis**.
   a. Urediospores $17-22 \times 12-18\mu$, teliospores $50-70 \times 18-28\mu$ . . . . 8. C. clematidis-apiifoliae Diet.
   b. Urediospores $18-32 \times 14-21\mu$, teliospores $60-105 \times 13-26\mu$ . . . . .7. C. clematidis (Thüm.) Barcl.
   c. Urediospores $28-42 \times 12-18\mu$ . . . . 9. C. elongatum Syd.

B. On family Rutaceae . . . . 10. C. phellodendri Kom.
C. On family Datiscaceae . . . . 11. C. datiscae Tranz.
D. On family Labiatae.
1. On species of Plectranthus; teliospores $50-75 \times 12-20\,\mu$ . . . . 13. C. plectranthi Barcl.
2. On other species of Labiatae; teliospores $65-100 \times 15-24\,\mu$. . . . . 12. C. perillae Kom.
E. On family Scrophulariaceae.
1. On species of Melampyrum . . 15. C. melampyri (Rebent.) Tul.
2. On other species of Scrophulariaceae . . . . 14. C. euphrasiae (Schum.) Winter.
F. On family Campanulaceae.
1. Urediospores $17-25 \times 12-19\,\mu$; on Codonopsis . . . . 17. C. horianum P. Henn.
2. Urediospores $21-35 \times 14-21\,\mu$; on other species of Campanulaceae . . . . 16. C. campanulae (Pers.) Lév.
G. On family Compositae.
1. On species of Aster . . . . 18. C. asterum (Diet.) Syd.
2. On species of Eupatorium . . . . 19. C. eupatorii Arth.
3. On Heteropappus . . . . . 20. C. heteropappi (P. Henn.) Tranz.
4. On species of Solidago . . . . 21. C. solidaginis (Schw.) Thüm.
5. On species of Inula. . . . . 22. C. inulae (Kunze) Rabenh.
6. On species of Carpesium . . . . 23. C. carpesii Sacc.
7. On Buphthalmum (Telekia) . . . . 24. C. telekiae Thüm.
8. On Tussilago farfara L. . . . .25. C. tussilaginis (Pers.) Lév.
9. On species of Petasites . . . . 26. C. petasitis (DC) Lév.
10. On Doronicum . . . . 27. C. doronici Namysl.
11. On species of Senecio . . . . 28. C. senecionis (Schum.) Fries.
12. On species of Cacalia and Adenostyles . . . . 29. C. cacaliae (DC) Otth.
13. On species of Ligularia . . . . 30. C. ligulariae Thüm.
14. On species of Saussurea . . . . 31. C. saussureae Thüm.
294 15. On species of Synurus . . . . 32. C. synuri Tranz.
16. On Cirgium japonicum DC . . . . . 33. C. cirsii-japonici Diet.
17. On Aposeris foetida Less. . . . . 34. C. aposeridis Syd.
18. On species of Sonchus . . . . 35. C. sonchi-arvensis (Pers.) Winter.
H. Uredio- and teliospores on incidental (unusual) hosts . . . . Coleosporium vagans (Dietr.) Tranz.

On Pinus

1. Coleosporium pinicola (Arth.) Jackson, Mem. Torrey Bot. Club, XVIII, 1931, p. 81; Arth., Manual Rusts U. S. a. Canada, 1934, p. 46, fig. 47; Jørstad, A Study of Kamtchatka Uredinales, 1934, p. 36, Fig. 1; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 43, 56, 70, 73.

Syn.: Coleosporium pini Gall., Journ. Mycol. VII, 1891, p. 44 (non C. pini Lagerh., 1889); Sacc., Sylloge, XI, 1895, p. 208.

Gallowaya pini Arth., Résult. scient. Congr. bot. Vienne, 1905, 1906, p. 336; N. Amer. Fl. VII, 1907, p. 95; Syd., Monogr. Ured. III, 1915, p. 657, tab. XXX, Fig. 188 (p. 605).

G. pinicola Arth., Bull. Torrey Bot. Club, XLVII, 1921, p. 36; N. Amer. Fl. VII, 1925, p. 661.

Aecia and urediospores absent.

Telia amphigenous on yellowish spots, 1.5 mm, when coalescing up to 10 mm, orange-red. Teliospores clavoid, tapering downward, 60—100 × 13—20 μ (according to Arthur), or 45—125 × 21—36 μ (according to Jørstad): walls colorless, with apical thickenings, swelling up to 30—50 μ (according to Jørstad, 6—23 μ, rarely up to 33 μ), smooth. (Figure 93).

Arthur maintains that there are rudimentary spermagonia, invisible on the outside.

The fungus was described in North America on **Pinus virginiana** Mill., ranging in the eastern states from Delaware to Tennessee.

Since in America the fungus is found on pines of the subgenus **Diploxylon**, but in Asia on species of the subgenus **Haploxylon**, it may be assumed that the Asian fungus is biologically different from the American; certain differences between the spore size of these fungi indicate the differentiation (see Jørstad, l. c.). A second closely related species, **Coleosporium crowellii** Cummins (Phytopathology, XXVIII, 1938, p. 523), was described, also in North America (New Mexico), on **Pinus flexilis** James, and **P. edulis** Engelm.

The pathogenicity of the fungus was not established.

On **Pinus sibirica** (Rupr.) Mayr. (= **P. cembra** var. **sibirica** Rupr.) — W SIBERIA: Ob (Omsk Region, Tara Subregion); E SIBERIA: Ang.-Say. (Sayans Mts., Krasnoyarsk Territory (?)).

On **Pinus pumila** (Pall.) Rgl. — FAR EAST: Kamch. (near Bogatyrevka in Avacha Bay).

On **Cedrus** sp. — Urals (Sverdlovsk Region: Ivdel' District).

FIGURE 93. **Coleosporium pinicola** Arth.) Jackson on **Pinus virgiana** Mill., Teliospores. (After Arthur)

FIGURE 94. **Coleosporium aconiti** Thum. on **Aconitum barbatum** Patr. Teliospores, × 600. (Orig.)

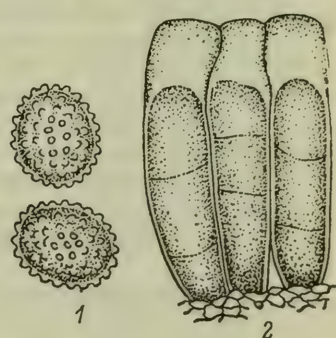


FIGURE 95. Coleosporium cimicifugatum Thüm. on Cimicifuga dahurica (Turcz.) Max.:

1 — urediospores; 2 — teliospores; × 600. (Orig.)

On Ranunculaceae

2. **Coleosporium aconiti** Thüm., Mycoth. univers. No. 1440, 1879
295 et Bull. Soc. imp. nat. Moscou, LV, 1880, p. 85; Sacc., Sylloge, VII, 1888, p. 758; Syd., Monogr. Ured, III, 1915, p. 650; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 188, 193.

Spermagonia and aecia unknown.

Uredia hypophyllous, circular, about 1 mm in diameter, orange-colored, later fading. Urediospores from globoid to ellipsoid or oblong, densely verrucose, 18 — 32 × 13 — 20 μ; wall colorless.

Telia hypophyllous, usually in groups, small, circular, 0.3 — 0.5 mm in diameter, occasionally coalescing irregularly, convex, orange-colored. Teliospores cylindrical or prismatic, 60 — 90 × 17 — 26 μ, rounded at the apex and greatly thickened, up to 12 — 20 μ (Figure 94).

On species of Aconitum, in Siberia.

On Aconitum barbatum Pers. — E SIBERIA: Ang.-Say. (Minusinsk).

On Aconitum excelsum Rchb. (= A. septentrionale auct.). — W SIBERIA: Irt. and Alt. (Altai).

3. **Coleosporium cimicifugatum** Thüm., Bull. Soc. imp. nat. Moscou, LIII, 1878, p. 222; Sacc., Sylloge, VII, 1888, p. 758; Syd., Monogr. Ured. III, 1915, p. 654; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 187, 193.

Spermagonia and aecia unknown.

Uredia hypophyllous, scattered on yellow areas, circular, about 0.3 — 0.5 mm in diameter, orange-colored, later fading. Urediospores from ovoid to oblong, densely verrucose, 18 — 35 × 16 — 20 μ; wall colorless.

Telia hypophyllous, on yellowed spots, usually gregarious, 1 — 4 mm wide, convex, 0.2 — 0.4 mm in diameter, orange, later brownish. Teliospores cylindrical, 50 — 90 × 16 — 25 μ, greatly thickened at apex, up to 12 — 20 μ. (Figure 95).

On species of Cimicifuga in the USSR: Siberia and the Far East; also in Manchuria and Japan. The warts on urediospores are rather coarse,
296 not delicate as described by Sydow.

On Cimicifuga foetida L. (= Actaea cimicifuga L.) — W SIBERIA: Ob (Tomsk, Eniseisk), Irt. and Alt. (Altai); E SIBERIA: Lena-Kol. (Yakut ASSR ASSR: Yakut Subregion), Ang.-Say. (Minusinsk, Sayans).

On Cimicifuga dahurica (Turcz.) Max. — FAR EAST: Uss. (Maritime Territory: Mongutaya Valley).

On Cimicifuga simplex Wormsk. — FAR EAST: Kamch., Ze.-Bu. (Amur Region: Udskoe; Khabarovsk Territory), Uss. (Maritime Territory).

On Cimicifuga yezoensis Kudo — FAR EAST: Sakh. (S Sakhalin, Kuril Is.).

On Cimicifuga sp. — FAR EAST: Sakh. (Sakhalin I.).

4. **Coleosporium actaeae** Karst., Öfvers. af Finska Vetensk. Soc. Förhandl. XLVI, 11 (1903) 1904, p. 6; Sacc., Sylloge, XVII, 1905, p. 398; Syd., Monogr. Ured. III, 1915, p. 650; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 187, 194.

Spermagonia and aecia unknown.

Uredia hypophyllous, on yellow patches, scattered or in small groups, circular, 0.5 — 0.3 mm in diameter, orange-colored, later faded. Urediospores from globoid to ellipsoid, verruculose, 20 — 32.4 × 16 — 21 μ, wall colorless.

Telia hypophyllous, on yellow spots, usually gregarious, in irregular groups, mostly loose, circular, 0.3 — 0.5 mm in diameter, convex, orange-colored. Teliospores cylindrical, rounded and strongly thickened at apex, 6 — 100 × 16 — 28 μ (Figure 96).

In the USSR on species of Actaea in Siberia and the Far East. The fungus does not spread to west of Tobol'sk. This species is possibly identical with Coleosporium cimicifugatum (both species were united by Jørstad in his work "Rust Fungi of Kamchatka" (1934), but the sculpture on the urediospores on Actaea proved to be finer than on Cimicifuga.

On Actaea acuminata Wallich — FAR EAST: Uss. (Maritime Territory: on the Maikhe River).

On Actaea erythrocarpa Fisch. — W SIBERIA: Ob (Omsk Region: near Tobol'sk; Novosibirsk Region: near Taiga station): E SIBERIA: Lena-Kol. (Yakut ASSR: near Olekminsk), Ang.-Say. (Irkutsk Region: near Utulik station).

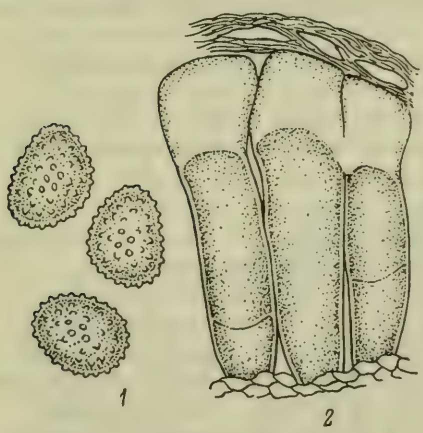


FIGURE 96. Coleosporium actaeae Karst. on Actaea erythrocarpa Fisch.:

1 — urediospores; 2 — teliospores; × 600. (Orig.)

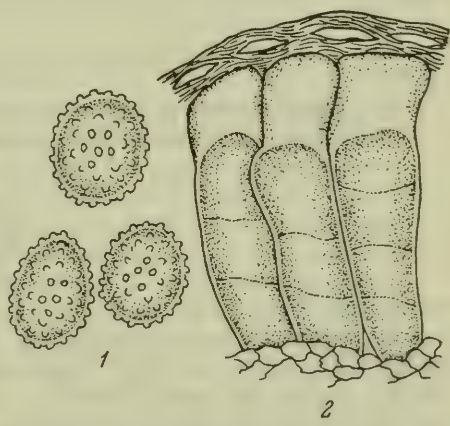


FIGURE 97. Coleosporium martianoffianum (Thüm.) Syd. on Delphinium elatum L.:

1 — urediospores; 2 — teliospores; × 600. (Orig.)

5. **Coleosporium martianoffianum** (Thüm.) Syd., Monogr. Ured. III, 1915, p. 654; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 193.

297 Syn.: Caeoma Martianoffianum Thüm., Bull. Soc. imp. nat. Moscou LIII, 1878, p. 220; Sacc., Sylloge, VII, 1888, p. 865.

Spermagonia and aecia unknown.

Uredia hypophyllous, on yellow patches, scattered or in groups, circular, 0.3 — 0.7 mm in diameter, orange-colored, later fading. Urediospores from globoid to ellipsoid, densely verrucose, 18 — 30 $\times$ 16 — 23 μ.

Telia hypophyllous on yellow patches, frequently in large loose groups varying in size, convex, orange-colored. Teliospores cylindrical, 60 — 95 $\times$ 18 — 25 μ, rounded and thickened at apex, up to 15 μ (Figure 97).

On species of Delphinium, described in the uredial stage from the neighborhood of Minusinsk (Krasnoyarsk Territory). Teliospores are first described here.

On Delphinium elatum L. (s. l.) — W SIBERIA: Ob (near Tobol'sk and Omsk, Tomsk), Irt. (Kazakh SSR: near Karakalinsk), Alt. (Altai); E SIBERIA: Ang.-Say.

On Delphinium grandiflorum L. — E SIBERIA: Ang.-Say. (Minusinsk, Sayans).

6. **Coleosporium pulsatillae** (Strauss) Lév., Ann. sci. natur. III, sér. VIII, 1847, p. 373; Sacc., Sylloge, VII, 1888, p. 754; Fischer, Ured. Schweiz, 1904, S. 439; Hariot, Uréd., 1908, p. 270; Liro, Ured. Fenn., 1908, p. 469; Migula, Kryptog.-Fl. Deutschl. III, 1, 1910, S. 466, Taf. X, Fig. 5; Taf. XB, Fig. 1 — 3; Klebahn, Kryptogfl. M. Brandb. Va, 1914, S. 732, Fig. M1 (p. 746); Trotter, Fl. Ital. Crypt. Ured., 1914, p. 377, fig. 14, 94; Syd., Monogr. Ured. III, 1915, p. 651; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 194.

Syn.: Uredo tremmelosa var. pulsatillae Strauss, Wetter. Ann. II, 1810, p. 89.

U. pulsatillae Steud. apud Duby, Bot. Gall. II, 1830, p. 895.

Coleosporium pulsatillarum Fries, Summa Veget. Scand. II, 1849, p. 512.

Peridermium Jaapii Kleb., Ztschr. Pflanzenkr. XII, 1902, S. 133.

Biol. Klebahn, l. c., 1902; Wirtswechs. Rostpilze, 1904, S. 372.

Spermagonia on needles, in rows forming small warts which are oblong to circular and which turn brown when dry, 0.5 — 0.75 mm in diameter.

Aecia on needles, 1 — 3 mm long, 0.5 mm wide; peridia vesicular, thin, of a single cell layer, up to 1.7 mm high, rupturing irregularly; peridial cells polygonal, usually pentagonal or hexagonal, 27 — 40 μ long, 18 — 28 μ wide, with verrucose wall. Aeciospores orange-colored, usually irregularly ovoid, angular, 25 — 40 $\times$ 16 — 24 μ: walls 3.5 — 4.5 μ thick, with a furrowed structure conferring on the spore surface a coarse verrucose appearance.

298 Uredia hypophyllous, on yellowed or brown spots, scattered or in groups, circular or elliptical, 0.5 — 1.0 mm in diameter, surrounded by the torn epidermis, orange-colored. Urediospores ovoid, ellipsoid or oblong, less frequently subgloboid, 18 — 50 $\times$ 10 — 15 μ; walls colorless, thin, the entire surface finely tuberculate.

Telia hypophyllous, small, about 0.5 mm in diameter, convex, blood-red. Teliospores cylindrical or prismatic, 65 — 100 $\times$ 10 — 22 μ; walls colorless, apical thickening up to 15 μ (Figure 98).

Aecia on Pinus silvestris, uredio- and teliospores on species of genus Pulsatilla.

On Pinus silvestris L. — EUROPEAN PART: U. Dns. (Lvov Region; see Coleosporium sp.).

On Pulsatilla patens (L.) Mill. (= Anemone patens L.) — EUROPEAN PART: Lad.-Ilm. (Leningrad Region), Balt. (Latvian SSR, Lithuanian SSR), U. V. (Yaroslav'l Region, Gorkii Region), V.-Kama (Gorkii Region, Kirov Region), U. Dnp. (Belorussian SSR), M. Dnp. (Kiev Region, Cherkassy District), V.-Don (Voronezh Region; Gorkii Region; Kuibyshev Region: Syzran; Penza Region: Kuznetsk), L. Don (Voronezh Region, Saratov Region); W SIBERIA: U. Tob. (Chelyabinsk Region), Ob (Novosibirsk Region, Krasnoyarsk), Irt. (Kazakh SSR: Semipalatinsk), Alt. (Altai); E SIBERIA: Ang.-Say. (Sayans; Minusinsk; Irkutsk Region: Balagansk; Buryat-Mongol ASSR: Barguzin, Kyakhta), Dau. (Chita Region: Nerchinsk).

On Pulsatilla angustifolia Turcz. — E SIBERIA: Lena-Kol. (Yakut ASSR: Yakut Subregion).

On Pulsatilla pratensis (L.) Mill. (incl. P. montana Hoppe) — EUROPEAN PART: Balt. (Lithuanian SSR), V.-Don (Voronezh, Kharkov), U. Dnp. (Kiev, Chernigov), U. Dns. (Ternopol' Region).

On Pulsatilla turczaninowii Kryl. et Serg. (= P. vulgaris auct., Fl. Sibir., non Mill.) — E SIBERIA: Ang.-Say. (Minusinsk; Lake Baikal; Buryat-Mongol ASSR: Kyakhta, Barguzin).

On Pulsatilla dahurica Spreng. — FAR EAST: Uss. (Maritime Territory: Pos'et District, Shkotovo District).

On Pulsatilla chinensis (Bge.) Reg. — FAR EAST: Uss. (Maritime Territory).

On Pulsatilla cernua Spreng. — FAR EAST: Uss. (Maritime Territory: Voroshilov, Novokievskoe).

The connection of aecia on Pinus silvestris with uredio- and teliospores on species of Pulsatilla was experimentally established by Klebahn (l. c.). The pathogenicity of the aecial stage on pines is apparently insignificant.

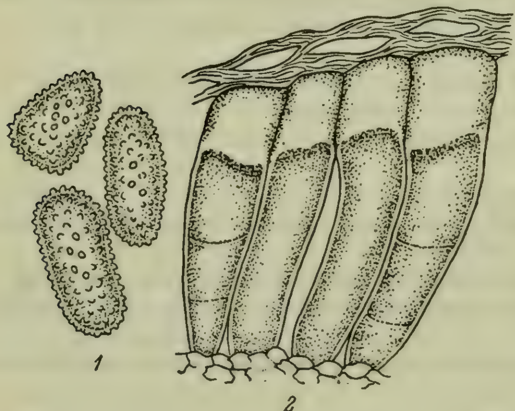


FIGURE 98. Coleosporium pulsatillae (Strauss) Lév. on Pulsatilla turczaninowii Kryl. et Serg.:

1 — urediospores; 2 — teliospores; × 600. (Orig.)

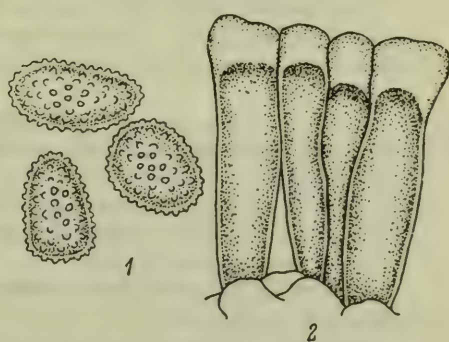


FIGURE 99. Coleosporium clematidis Thüm.) Barcl. on Clematis manshurica Rupr.:

1 — urediospores; 2 — teliospores; × 600. (Orig.)

299 7. Coleosporium clematidis (Thüm.) Barcl., Descript. List. Ured. Simla, III, in Journ. Asiat. Soc. Bengal, LIX, pt. II, 1890, p. 89; Sacc., Sylloge, IX, 1891, p. 317; Syd., Monogr. Ured. III, 1915, p. 653; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 194.

Syn.: Caeoma clematidis Thüm., Mycoth. univers. No. 539, 1876; Sacc., Sylloge, VII, 1888, p. 867.

Spermagonia and aecia unknown.

Uredia hypophyllous, occasionally in smaller numbers also epiphyllous, frequently scattered on yellowed patches, circular, small, 0.3 — 0.5 mm in diameter, yellow or orange-colored. Urediospores globoid, ovoid, ellipsoid or oblong, densely verrucose, $18-32 \times 14-21\mu$; walls colorless, 1.5μ to 2.5μ thick.

Telia hypophyllous, scattered or, frequently, in circular or irregular rings, 0.5 — 1 mm in diameter, convex, orange-colored. Telia from cylindrical to clavate, with strong apical thickenings ($15-25\mu$), usually rounded at the base, $60-105 \times 13-26\mu$ (Figure 99).

On species of genus **Clematis** in eastern and southeastern Asia and in Africa. The fungus was described from the teliospore stages on **Clematis montana** and **C. buchaniana** in Simla (in the Himalayas), and on **C. brachiata** in southern Africa. On species of the genus **Clematis** the following closely related species have been described: **Coleosporium clematidis-apiifoliae** Diet. on **C. apiifolia** and **C. paviloba** (in Japan and China), and **Coleosporium elongatum** Syd. on **C. hedysarifolia** (in Japan).

On **Clematis manshurica** Rupr. — FAR EAST: Uss. (Maritime Territory).

On **Clematis hexapetala** Pall. (= **C. angustifolia** DC, non Jack.) — FAR EAST: Uss. (Maritime Territory: near Voroshilov).

On **Clematis serratifolia** Rehder (= **C. Wilfordii** Kom. ? may be **C. brevicaudata** DC) — FAR EAST: Uss. (Maritime Territory: near Vladivostok).

Coleosporium clematidis-apiifoliae Diet., Engler's Bot. Jahrb. XXVIII, 1900, S. 287; Sacc., Sylloge, XVI, 1902, p. 316; Syd., Monogr. Ured. III, 1915, p. 653; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 194.

According to Sydow, this species is distinguished from **Coleosporium clematidis** Barcl. on Clematis apiifolia and C. parviloba in Japan and China by the smaller urediospores ($17-22 \times 12-18\mu$) and by shorter (on an average) teliospores ($50-70 \times 18-28\mu$).

The existence of forms of this species on **Clematis** has not yet been proved in the USSR. A third species — **C. elongatum** H. et P. Syd. — on Clematis hedysarifolia is distinguished by more elongate urediospores.

300 9. **Coleosporium elongatum** Syd., Ann. mycol. XII, 1914, p. 196; Syd., Monogr. Ured. III, 1915, p. 654; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 194.

This species, found in Japan on **Clematis hedysarifolia**, was separated by Sydow on account of the narrow, elongate urediospores, $28-42 \times 12-18\mu$. It is not found in the USSR.

The stability of characteristics of this and preceding species on **Clematis** has not been proved.

On Phellodendron (Rutaceae)

10. **Coleosporium phellodendri** Kom. in Jacz., Kom. et Tranz., Fungi Rossiae exs. No. 274, 1899; Dietel, Engler's Bot. Jahrb. XXVIII, 1900, S. 287; Sacc., Sylloge, XVI, 1902, p. 317; Syd., Monogr. Ured. III, 1915, p. 648; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 264.

Spermagonia and aecia unknown.

Uredia hypophyllous, often on yellow patches scattered or more or less densely grouped, circular, 0.3 — 0.5 mm in diameter, orange-colored. Urediospores globoid, ovoid or ellipsoid, rather coarsely verrucose, $20-30 \times 19-27\,\mu$; walls colorless, $2-3\,\mu$ thick.

Telia hypophyllous, usually in groups, circular, small, 0.2 — 0.4 mm in diameter, orange-colored, convex. Teliospores cylindrical or clavate, $60-110 \times 18-30\,\mu$, rounded and strongly thickened at apex ($10-20\,\mu$), usually rounded at the base (Figure 100).

On **Phellodendron**; the fungus is widespread in the Far Eastern Territory of the USSR, as well as in Manchuria, North Korea, and Japan.

On **Phellodendron amurense** Rupr. — FAR EAST: Uss. (Maritime Territory).

The wide distribution of the fungus probably causes considerable damage, since photosynthesis is disrupted by the premature death of the severely infected leaves.

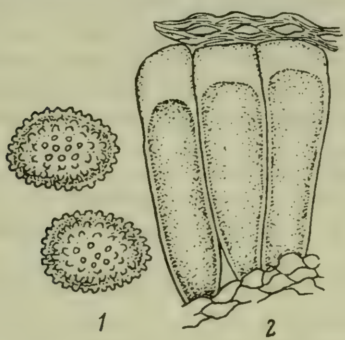


FIGURE 100. **Coleosporium phellodendri** Kom. on **Phellodendron amurense** Rupr.:

1 — urediospores; 2 — teliospores; × 600. (Orig.)

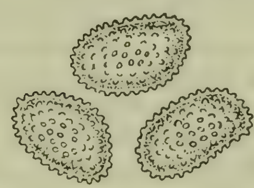


FIGURE 101. **Coleosporium datiscae** Tranz. on Datisca cannabina L. Urediospores, × 600. (Orig.)

On D a t i s c a c e a e

11. C o l e o s p o r i u m d a t i s c a e Tranz., Tr. Tifl. Bot. Sada, XI, 1910, p. 147 and in Tranzschel et Serebriannikow, Mycotheca Rossiae, No. 16, 1910; Sacc., Sylloge, XXI, 1912, p. 722; Syd., Monogr. Ured. III, 1915, p. 646; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 283.

Spermagonia and aecia unknown.

Uredia hypophyllous and caulicolous, often on yellow areas, scattered or in groups, round, minute, 0.1 —0.2 mm in diameter, occasionally coalescent and covering significant portions of the leaves, surrounded by the torn epidermis, pale orange-colored. Urediospores globoid, ellipsoid, ovoid,
301 or oblong, densely verrucose, $20-35 \times 13-21\,\mu$; walls colorless, about $1.5\,\mu$ thick (Figure 101).

Telia hypophyllous, scattered, round, irregular, small, 0.2 — 0.3 mm in diameter, pale orange-colored. Teliospores cylindrical, clavate, $65-90 \times 15-24\,\mu$, rounded and strongly thickened at apex ($15-25\,\mu$).

On Datisca in the USSR (Transcaucasia, Central Asia), and in northern India.

On Datisca cannabina L. — CAUCASUS: W Transc. (Adzhar ASSR: Cape Zelenyi near Batumi; Georgian SSR: Tsubi village near Kutaisi); CENTRAL ASIA: Pam.-Al. (Tadzhik SSR: southern slopes of the Gissar Range, Kondor Ravine (frequently)).

On Labiatae

12. **Coleosporium perillae** Kom. in Jacz., Kom. et Tranz., Fungi Rossiae exs. No. 273, 1889; Syd., Hedwigia, XXXVIII, 1899, S. (141); Sacc., Sylloge, XVI, 1902, p. 317; Syd., Monogr. Ured. III, 1915, p. 641; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 53, 330.

Spermagonia and aecia unknown.

Uredia hypophyllous, scattered or loosely grouped, round, 0.2 — 0.6 mm in diameter, orange-colored. Urediospores globoid, ovoid, or ellipsoid, densely verrucose, $18-27 \times 15-20\,\mu$; walls colorless, about $1.5\,\mu$ thick.

Telia hypophyllous, scattered, round or oblong, 0.5 — 1.0 mm in diameter, orange-colored. Teliospores clavate, $65-100 \times 15-24\,\mu$, rounded and strongly thickened at apex, slightly tapering toward the base (Figure 102).

On Perilla and other Labiatae.

General distribution: Far East, northern India.

In Manchuria and northern India the fungus occurs on Perilla, in Japan also on Esholtzia, Keiskea, and Mosla. It is possible that Coleosporium perillae is identical with C. plectranthi.

On Perilla acymoides L. — FAR EAST: Uss. (Maritime Territory: near Pos'et).

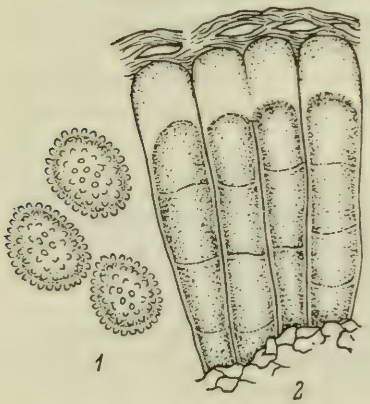


FIGURE 102. **Coleosporium perillae** Kom. on **Perilla ocymoides** L.:

1 — urediospores; 2 — teliospores; × 600. (Orig.)

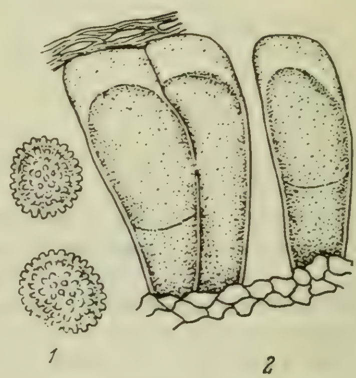


FIGURE 103. **Coleosporium plectranthi** Barck. on **Plectranthus glaucocalyx** Max.:

1 — urediospores; 2 — teliospores; × 600. (Orig.)

13. **Coleosporium plectranthi** Barcl., Descript. List Ured. Simla, III in Journ. Asiat. Soc. Bengal, LIX, pt. II, 1890, p. 89, tab. VI, fig. 4; Sacc., Sylloge, IX, 1891, p. 317; Syd., Monogr. Ured. III, 1915, p. 641; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 330.

302 Spermagonia and aecia unknown.

Uredia hypophyllous, frequently on yellow spots, scattered, occasionally in rings, round, small, 0.2—0.3 mm in diameter, orange-colored. Urediospores globoid or ovoid, densely verrucose, 17—24 × 12—18 μ; walls colorless, 1—1.5 μ thick.

Telia hypophyllous, scattered or in rings, small, round, 0.2—0.3 mm in diameter, orange-colored. Teliospores cylindrical or clavate, 50—75 × 12—20 μ, rounded or slightly narrowing at apex. Thickening up to 15—25 μ, slightly tapering at the base. (Figure 103).

On species of Plectranthus. The fungus was described on Plectranthus gerardianus in the vicinity of Simla in the Himalayas; found in the USSR (Far East), Manchuria, and Japan.

On Plectranthus glaucocalyx Max. — FAR EAST: Uss. (Maritime Territory: city of Voroshilov, Suchan and Lyanchikhe rivers).

On Labiatae, apart from the species mentioned, is known Coleosporium lycopi Syd. (teliospores 55—90 × 15—24 μ, urediospores not described) on Leucopus "europaeus," and also Coleosporium salvae Diet. (urediospores up to 20—30 × 14—24 μ, teliospores not described) on Salvia japonica var. bipinnata, both described from Japan (Sydow, Monog. Ured. III, 1915, pp. 462, 641).

On Scrophulariaceae

14. **Coleosporium euphrasiae** (Schum.) Winter, pr. p., emend. Kleb., 1895; Winter, Pilze Deutschl., 1881, S. 246, pr. p.; Sacc., Sylloge, VII, 1888, p. 754; Fischer, Ured. Schweiz, 1904, S. 442; Hariot, Uréd., 1908, p. 272; Liro, Ured. Fenn., 1908, p. 473; Bubák, Rostpilze Böhmens, 1908, S. 182; Migula, Kryptog.-Fl. Deutschl. III, 1, 1910, S. 465, Taf. X, Fig. 4; Klebahn, Kryptogfl. M. Brandb. Va, 1914, S. 734, Fig. M2 (p. 722); Trotter, Fl. Ital. Crypt. Ured., 1914, p. 375, fig. 12, 28b, 93; Syd., Monogr. Ured. III, 1915, p. 637; Fragoso, Fl. Iber. Ured. II, 1925, p. 315; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 337.

Syn.: Uredo euphrasiae Schum., Pl. Saell. II, 1803, p. 230.

Coleosporium rhinanthacearum (DC, 1808) Lév., Ann. sci. natur. III, sér. VIII, 1847, p. 373, pr. p.; Grove, Brit. Rust Fungi, 1913, p. 326.

Peridermium Stahlii Kleb., Ztschr. Pflanzenkr. II, 1892, S. 269.

Biol. Klebahn, Ztschr. Pflanzenkr. II, 1892, S. 264; IV, 1894, S. 9; V, 1895, S. 13; Wirtswechs. Rostpilze, 1904, S. 369; Wagner, Ztschr. Pflanzenkr. VIII, 1898, S. 261.

Spermagonia mainly epiphyllous, up to 0.5 mm wide and 1 mm long.

Aecia amphigenous, scattered, 1—2 mm long, 0.25 mm wide, up to 1 mm high; peridial cells in one layer. Their walls uniformly thick, about 3 μ, slightly thicker than in C. senecionis. Aeciospores mostly ovoid, globoid,
303 rarely ellipsoid, 15—35 μ (usually 20—30) × 15—24 μ; walls 2—3 μ thick, verrucose; contents orange-yellow.

Uredia hypophyllous, small; about 0.5 mm in diameter, orange-colored. Urediospores globoid or ovoid, rarely prismatic, frequently angular, $18-29 \times 13-18\,\mu$; walls, about $1\,\mu$ thick, verrucose.

Telia hypophyllous, also on stems and petioles, rather thick, waxy, red. Teliospores prismatic, $68-75$ $(105) \times 15-24\,\mu$, thickened at apex, up to $10-15\,\mu$.

Basidiospores ovoid with unequal sides and small lateral papillae, $20-22.5 \times 12.5-16.5\,\mu$ (Figure 104).

Aecia on Pinus silvestris, uredio- and teliospores on Euphrasia, Rhinantus, (Alectorolophus) Odontites, Rhynchocoris, Pedicularis.

General distribution: Europe, Asia.

On Euphrasia officinalis L. (in s. l.) — EUROPEAN PART: Dv.-Pech. (Arkhangel'sk Region), Lad.-Ilm. (Leningrad Region), U. V. (Kalinin, Moscow, Ivanovo, and Smolensk regions), V.-Kama (Ivanovo and Kirov regions, Tatar ASSR), U. Dnp. (Orel and Smolensk regions, Belorussian SSR; Chernigov, Kiev), U. Dns. (Lvov and Ternopol' regions), U. Dnp. (Kursk Region), V.-Don (Kuibyshev Region), Crim. (Nature Reserve); CAUCASUS: E Transc. (Georgian SSR: Bakuriani): W. SIBERIA: Ob (Omsk Region, Tobol'sk).

On Euphrasia stricta Host. — EUROPEAN PART: Balt. (Lithuanian SSR) V.-Kama (Kirov Region).

On Euphrasia tatarica Fisch. — EUROPEAN PART: L. Don (Saratov Region: Saratov); W SIBERIA: Ob (Omsk Region: Ishim. District).

On Euphrasia reuteri Wettst. — EUROPEAN PART: Kar.-Lap. (Karelian ASSR).

On Euphrasia brevipila Burn. et Gr. — EUROPEAN PART: Kar.-Lap. (Karelian ASSR), Dv.-Pech. (Arkhangel'sk and Vologda regions), Lad.-Ilm. (Leningrad Region), V.-Don (Ukrainian SSR), U. Dnps. (Belorussian SSR).

On Euphrasia curta Fr. — EUROPEAN PART: Kar.-Lap. (Karelian ASSR), Lad.-Ilm. (Leningrad Region), U. V. (Moscow Region).

On Euphrasia fennica Kihlm. — EUROPEAN PART: Kar.-Lap. (Karelian ASSR).

On Euphrasia regelii Wettst. — CAUCASUS: W Transc. (Abkhaz ASSR).

On Euphrasia rostkoviana Hayne — EUROPEAN PART: U. V. (Moscow Region).

On Odontites rubra Gilib. — EUROPEAN PART: Kar.-Lap. (Karelian ASSR), Lad.-Ilm. (Leningrad Region), Balt. (Latvian SSR), U. V. (Moscow, Smolensk, and Ivanovo regions), V.-Kama (Ivanovo and Kirov regions), M. Dnp. (Kursk Region, Poltava Region: Poltava), U. Dnp. (Smolensk
'304 Region, Belorussian SSR; Chernigov Region: Chernigov), V.-Don (Kursk and Voronezh regions), Transv. (Bashkir ASSR: Belebei), L. Don (Saratov Region: Balashov).

On Odontites serotina (Lam.) Rchb. — EUROPEAN PART: Balt. (Latvian) SSR, Lithuanian SSR, Estonian SSR).

On Rhinanthus (Alectorolophus) major Ehrh. — EUROPEAN PART: Dv.-Pech. (Arkhangel'sk Region: Kargopol'), Kar.-Lap. (Karelian ASSR), Lad.-Ilm. (Leningrad Region), Balt. (Lithuanian SSR, Latvian SSR, Estonian SSR), U. V. (Kalinin, Moscow, and Smolensk region), V.-Kama(Kirov Region), U. Dnp. (Smolensk Region, Belorussian SSR), M. Dnp. (Ukranian SSR), V.-Don (Syzran), Transv. (Bashkir ASSR: Belebei); W SIBERIA: Ob (Omsk Region, Tobol'sk, Novosibirsk Region), Irt., Alt. (Altai Territory); CAUCASUS: E Transc. (Georgian SSR: Bakuriani).

On **Rhinanthus minor** Ehrh. — EUROPEAN PART: Kar.-Lap. (Karelian ASSR), Dv.-Pech. (Arkhangel'sk Region: Kargopol'), Lad.-Ilm. (Leningrad Region), Balt. (Lithuanian SSR, Latvian SSR, Estonian SSR), U. V. (Moscow and Smolensk regions), V.-Kama (Kirov Region), U. Dnp. (Belorussian SSR), M. Dnp. (Chernigov Region: Priluki).

On **Rhinanthus stenophyllus** (Schum.) B. Fedtsch. — EUROPEAN PART: Lad.-Ilm. (Leningrad Region).

On **Rhynchocoris orientalis** Benth. — CAUCASUS: Cisc. (Ordzhonikidze Territory: Ordzhonikidze).

On **Pedicularis resupinata** L. W SIBERIA: Ob (Omsk Region: Tara, Omsk; Tomsk; Krasnoyarsk Territory; Krasnoyarsk, Eniseisk): E SIBERIA: Ang.-Say. (Krasnoyarsk Territory: Minusinsk; Irkutsk), Dau. (Buryat-Mongol ASSR: Kyakhta).

On **Pedicularis uncinate** Steph. — W SIBERIA: Ob (Novosibirsk Region, Tomsk).

On **Pedicularis proboscidea** Stev. — W SIBERIA: Irt. (Altai Territory: Rubtsovsk District).

On **Pedicularis comosa** L. — W SIBERIA: Ob (Krasnoyarsk Territory: near Eniseisk).

On **Pedicularis rubens** Steph. — E SIBERIA: Ang.-Say. (Irkutsk Region).

On **Pedicularis laeta** Stev. (?) — E SIBFRIA: Ang.-Say. (Krasnoyarsk Territory: Minusinsk).

In 1892 Klebahn transferred aeciospores (**Peridermium stahlii** Kleb.) from **Pinus silvestris** on **Alectorolophus** (**Rhinanthus**), and later infected **Euphrasia** with the urediospores from **Alectorolophus**. The fungus on **Melampyrum**, earlier united with **Coleosporium euphrasiae**, proves to be biologically separate. The fungi on **Odontites**, **Rynchocoris**, and **Pedicularis** have not been proved to belong to **C. euphrasiae**.

(303)

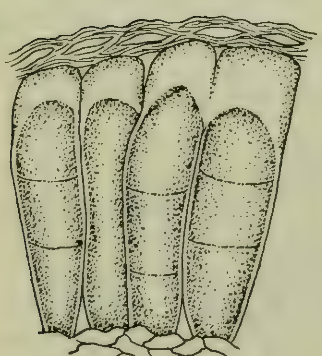


FIGURE 104. **Coleosporium euphrasiae** (Schum.) Winter on **Rhinanthus** sp. teliospores, × 600. (Orig.)

(305)

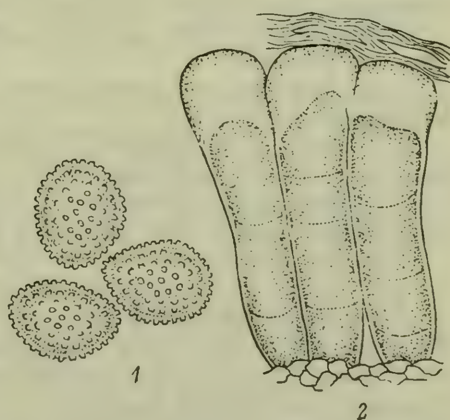


FIGURE 105. **Coleosporium melampyri** (Rebent) Tul. on **Melampyrum nemorosum** L.:

1 — urediospores; 2 — teliospores; × 600.(Orig.)

15. **Coleosporium melampyri** (Rebent.) Tul. emend. Kleb.,
Ztschr. Pflanzenkr. V, 1895, S. 13; Fischer, Ured. Schweiz, 1904, S. 440,
Fig. 299; Hariot, Uréd., 1908, p. 273, fig. 39; Liro, Ured. Fenn., 1908, p. 470;
Migula, Kryptog-Fl. Deutschl. III, 1, 1910, S. 465, Taf. X, Fig. 3; Trotter,
Fl. Crypt. Ital. Ured., 1914, p. 376; Klebahn, Kryptogfl. M. Brandb. Va,
305 1914, S. 746, Fig. M3 (p. 746); Syd., Monogr. Ured. III, 1915, p. 639;
Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 337.

Syn.: Uredo melampyri Rebent., fl. Neomarch., 1804, p. 355.

Uredo ringentium Mart. var. melampyri Mart., Prodr. fl. Mosqu., ed. II, 1817, p. 230.

Coleosporium rhinanthacearum (DC, 1808, pr. p.) Lév., Ann. sci. natur. III, sér. VIII, 1847, p. 373, pr. p.

Coleosporium melampyri Tul., Ann. sci. natur. 4, sér. II, 1854, p. 136, pr. p.; Karsten, Mycol. Fenn. IV, 1878, p. 62, pr. p.; Grove, Brit. Rust Fungi, 1913, p. 327, fig. 245.

Peridermium Soraueri Kleb., Ztschr. Pflanzenkr. V, 1895, S. 259.

Coleosporium melampyri Karst., Mycol. Fenn. IV, 1878, p. 62, pr. p.; Sacc., Sylloge, XXI, 1912, p. 722.

Biol. Klebahn, l. c., 1895; Ztschr. Pflanzenkr. V, 1895, S. 257; VI, 1896, S. 335; Wirtswechs. Rostpilze, 1904, S. 370; Wagner, Ztschr. Pflanzenkr. VIII, 1898, S. 270; Mayor, Bull. Soc. Neuchât. sci. natur. XLVIII, 1923, p. 386.

Spermagonia mostly epiphyllous, about 0.5 mm wide, up to 1 mm long.

Aecia amphigenous, up to 2 mm long, about 0. 25 mm wide, 1 mm high; peridial cells densely verrucose. Aeciospores ovoid, rarely globoid or oblong, $22-25 \times 17-24\,\mu$; walls colorless, verrucose, $3-4\,\mu$ thick; contents orange-colored.

Uredia hypophyllous, orange-colored, small, about 0.5 mm in diameter. Urediospores globoid, ovoid, or ellipsoid, often slightly angular, $19-30 \times 12-25\,\mu$; walls colorless, thin, verrucose.

Telia hypophyllous, scattered or in groups, waxy, red. Teliospores prismatic, $70-85 \times 14-20\,\mu$, thickened at apex up to $10-18\,\mu$.

Basidiospores ovoid, $22.5 \times 15\,\mu$, with a colorless lateral beak at the base (Figure 105).

Aecia on Pinus silvestris, uredio- and teliospores on species of Melampyrum.

The fungus is widespread in Europe and is found also in Siberia, Manchuria, Korea, and Japan.

On Melampyrum cristatum L. — EUROPEAN PART: Lad.-Ilm. (Leningrad Region), Balt. (Estonian SSR), L. Don (Saratov Region).

On Melampyrum arvense L. — EUROPEAN PART: Balt. (Estonian SSR), V.-Don (Saratov): CAUCASUS: W Transc. (Abkhaz ASSR: Novyi Afon).

On Melampyrum nemorosum L. — EUROPEAN PART: Kar.-Lap.
(Karelian ASSR), Dv.-Pech. (Arkhangel'sk Region: Kargopol'), Lad.-Ilm.
306 (Leningrad Region), Balt. (Lithuanian SSR, Estonian SSR), U. V. (Kalinin,
Smolensk, and Moscow regions), Ukrainian SSR: Lvov Region, M. Dnp.
(Kursk Region, Chernigov Region: Priluki), V.-Don (Kursk and Voronezh
regions; Penza Region: Kuznetsk), L. Don (Saratov).

On Melampyrum pratense L. — EUROPEAN PART: Kar.-Lap. (Karelian ASSR), Dv.-Pech. (Arkhangel'sk and Vologda regions), Lad.-Ilm. (Leningrad Region), Balt. (Lithuanian SSR, Estonian SSR), U. V. (Kalinin, Moscow, Smolensk and Ivanovo regions), V.-Kama (Kirov Region), U. Dnp. (Smolensk Region, Belorussian SSR), M. Dnp. (Ukrainian SSR).

On Melampyrum silvaticum L. — EUROPEAN PART: Lad.-Ilm. (Leningrad Region), Balt. (Estonian SSR), U. V. (Ivanovo Region), U. Dnp. (Belorussian SSR), U. Dns. (Stanislav Region).

Coleosporium melampyri was separated from C. euphrasiae by Klebahn 1895) because aeciospores from Pinus silvestris (=Peridermium Soraveri Kleb.) were infective for Rhinanthus but not for Melampyrum and, vice versa, those infective for Melampyrum failed to infect Rhinanthus. Klebahn's findings were confirmed by Mayor (1925) in experimental infections of Melampyrum pratense with aeciospores from Pinus silvestris.

On Campanulaceae

16. Coleosporium campanulae (Pers.) Lév., Ann. sci. natur. III, sér. VIII, 1847, p. 373; Sacc., Sylloge, VII, 1888, p. 763; Fischer, Ured. Schweiz, 1904, S. 443; Arth., N. Amer. Fl. II, 1907, p. 88; 1924, p. 653; Manual Rusts U. S. a. Canada, 1934, p. 40, fig. 57; Liro, Ured. Fenn., 1908, p. 457; Bubák, Rostpilze Böhmens, 1908, S. 181; Migula, Kryptog.-Fl. Deutschl. III, 1, 1910, S. 465; Grove, Brit. Rust Fungi, 1913, p. 328, fig. 246, 247; Klebahn, Kryptogfl. M. Brandb. Va, 1914, S. 738, 901, Fig. M4 (746); Trotter, Fl. Crypt. Ital. Ured., 1914, p. 374; Syd., Monogr. Ured. III, 1915, p. 628; Fragoso, Fl. Iber. Ured. II, 1925, p. 318, fig. 150; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 262. 353.

Syn.: Uredo campanulae Pers., Syn. fung., 1801, p. 217; Martius, Prodr. fl. Mosqu., ed. II, 1817, p. 230.

Caeoma campanularum Link. Spec. plant. II, 1825, p. 16.

Coleosporium campanulacearum Fries, Summa Veget. Scand., 1849, p. 512.

Peridermium Rostrupii E. Fisch., Bull. Soc. bot. France, XLI, 1894, p. CLXXII.

Biol. Rostrup, Bot. Tidsskr., 1894, p. 38; Fischer, Bull. Soc. bot. France, LXI, 1894, p. CLXXI; Beitr. Kryptogfl. Schweiz, II, 1904, S. 105; Wagner, Ztschr. Pflanzenkr. VIII, 1898, S. 257; Klebahn, Ztschr. Pflanzenkr. II, 1892, S. 265; IV, 1894, S. 12; XV, 1905, S. 82; XVII, 1907, S. 146; XXIV, 1914, p. 16; Jahrb. Hamburg. wiss. Anst. XX, 1902, S. 25; Wirtswechs. Rostpilze, 1904, S. 365; Killerman, Journ. Mycol. XI, 1905, p. 32; Hirats., Bot. Mag. Tokyo, XLVIII, 1934, p. 364—366.

Spermagonia mainly epiphyllous, up to 1 mm long, and 0.5 mm wide.

Aecia amphigenous, 0.25 mm wide, up to 2 mm long, and 1.5 mm high. Aeciospores prismatic, ovoid, rarely globoid, $23-43 \times 13-19\,\mu$; walls colorless, $3-4\,\mu$ thick, densely verrucose; contents orange-colored.

Uredia hypophyllous, scattered or in groups, occasionally also on stems,
307 circular, orange-red. Urediospores globoid, ovoid, or ellipsoid, often slightly angular, $21-35 \times 14-21\,\mu$; walls colorless, $1.5\,\mu$ thick, densely verrucose; contents orange-colored.

Telia small, more or less coalescent, orange-colored, later blood-red. Teliospores cylindrical, 50—72 (100) × 14—17 (28) μ, greatly thickened at apex, 12—15 μ. (Figure 106).

Aecia on species of **Pinus**. Uredio- and teliospores on **Campanulaceae** (**Campanula, Symphyandra, Adenophora, Phyteuma, Lobelia**, etc.).

General distribution: Europe, Asia, North America.

This species is divided into several specialized forms.

Forma sp. **campanulae rapunculoides** Kleb., on **Campanulae rapunculoides** L. The sori frequently cover the entire frond. In experimental cultures the fungus was transferred (by Klebahn) onto **Campanula bononiensis** L., **C. glomerata** L., **C. lamiifolia** M. B., **C. latifolia** L., **C. nobilis** Lindl., **Phyteuma spicatum** L., **P. orbiculare** L., **Tropaeolum minus** L., **Schizanthus grahami** Gill.; it could not be cultured on **C. trachelium** L., **C. rotundifolia** L., etc. The connection with aecia on **Pinus** was established by Klebahn.

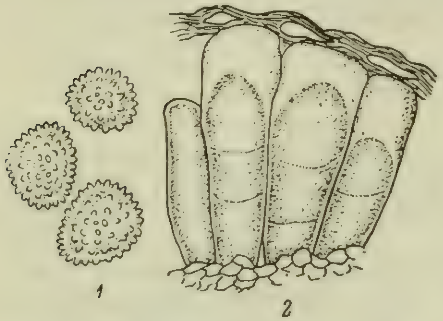


FIGURE 106. **Coleosporium campanulae** (Pers.) Lév. on **Campanula trachelium** L.:

1 — urediospores; 2 — teliospores; × 600. (Orig.)

Forma sp. **campanulae trachelii** on **Campanula trachelium** L. The sori frequently line the entire underside of the leaves. In cultures it attacks **Campanula latifolia** L. var. **macrantha** Fisch., **C. nobilis** Lindl., **C. bononiensis** L., **C. glomerata** L., **C. glomerata** L. var. **dahurica**, **C. patula** L., **Schizanthus grahami** Gill., **Tropaeolum minus** L.; faintly infects **C. rapunculoides** L. and **Wahlenbergia hederacea** Rchb.; fails to infect **C. rotundifolia** L., **C. Pusilla** Haenke, **C. turbinata** Schott., etc. Connection of the fungus with **Pinus silvestris** was established by Fischer and Wagner.

Forma sp. **campanulae rotundifoliae** Kleb. on **Campanula rotundifolia** L. In cultures the fungus proved infective for **Phyteuma spicatum** L., **Campanula pusilla** Haenke, **C. turbinata** Schott, **C. bononiensis** L., **Wahlenbergia hederacea** Reichenb., etc.; but not for **Campanula trachelium** L., **C. rapunculoides** L., etc.

Forma sp. **campanulae adenophorae** Kupr. on **Adenophora**. According to Hiratsuka experimental cultures of the fungus on **Campanula lasiocarpa** acut., **C. pilosa** Pall. var. **dasyantha**, **C. punctata** auct. var. **typica**, **Lobelia sessifolia** Lamb., **Wahlenbergella gracilis** Tolmatch., etc. failed. Aecia were produced on **Pinus densiflora** S. et Z. and **P. thunbergii** Parlat.; ineffective on **P. koraiensis** Sieb. et Zucc. and **P. pentaphylla** Mayr. (in Japan). The change of hosts was studied in experimental cultures by Hiratsuka (1934).

Species on **Pinus** (see above).

On **Campanula sibirica** L. — EUROPEAN PART: V.-Don (Syzran), M. Dnp. (Ukrainian SSR: Korsun), Crim., L. Don (Saratov); CAUCASUS: Cisc. (in former Terek Region); W SIBERIA: Ob (Novosibirsk), Irt. (Ruch'evka near the village of Kolyvanskoe in Altai).

308 On Campanula alliariifolia Willd. — CAUCASUS: W Transc. (Sochi, Abkhazian ASSR: Gagra), E Transc. (Georgian SSR: Borzhomi, Tbilisi), S Transc. (Armenian SSR: Delizhan, Lori).

On Campanula collina M. B. — CAUCASUS: E Transc. (Georgian SSR: Bakuriani).

On Campanula sarmatica Ker. — CAUCASUS: E Transc. (Georgian SSR: Bakuriani).

On Campanula tridentata Schreb. — CAUCASUS: E Transc. (Georgian SSR: Bakuriani).

On Campanula aucheri DC — CAUCASUS: E Transc. (Georgian SSR: Bakuriani).

On Campanula rotundifolia L. — EUROPEAN PART: Kar.-Lap. (Murmansk Region: former Murmansk Subregion; Karelian ASSR), Dv.-Pech. (Arkhangel'sk Region: Kargopol'), Lad.-Ilm. (Leningrad Region), Balt. (Lithuanian SSR), U. V. (Kalinin and Moscow regions), V.-Kama (Kirov Region, Sverdlovsk Region: Krasnoufimsk), U. Dnp. (Smolensk Region, Belorussian SSR), M. Dnp. (Kursk Region), V.-Don (Voronezh Region), L. Don (Saratov Region: Balashov).

On Campanula latifolia L. — EUROPEAN PART: Kar.-Lap. (Karelian ASSR), Lad.-Ilm. (Leningrad Region), U.V. (Moscow Region), V.-Kama (Kirov Region), U. Dnp. (Smolensk and Orel regions), V.-Don (Chuvash ASSR: Yadrin); CAUCASUS: Cisc. (Ordzhonikidze), E Transc. (Georgian SSR: Bakuriani).

On Campanula trachelium L. — EUROPEAN PART: Lad.-Ilm. (Leningrad Region), U. V. (Kalinin Region: Ostashkov), Balt. (Lithuanian SSR, Estonian SSR), U. V. (Moscow Region), V.-Kama (Tatar ASSR: village of Lapshevo; Molotov Region; Sverdlovsk Region: Krasnoufimsk), M. Dnp. (Kursk Region; Ukrainian SSR: Ternopol' Region, Priluki, Vinnitsa), V.-Don (Voronezh Region; Molotov, Syzran).

On Campanula rapunculoides L. — EUROPEAN PART: Kar.-Lap. (Karelian ASSR), Lad.-Ilm. (Leningrad Region), Balt. (Estonian SSR, Latvian SSR, Lithuanian SSR), U. V. (Kalinin and Moscow regions), V.-Kama (Tatar ASSR), U. Dnp. (Belorussian SSR), U. Dns. (Lvov, Drogabych, and Ternopol' regions), M. Dnp. (Kursk Region, Ukrainian SSR: Priluki), V.-Don (Voronezh Region; Ul'yanovsk, Kharkov: University Garden); CAUCASUS: Cisc. (Krasnodar Territory, Ordzhonikidze Territory, Zheleznovodsk), W Transc. (Krasnodar Territory: Sochi; Georgian SSR: Kutaisi), E Transc. (Georgian SSR: Tbilisi, Bakuriani).

On Campanula bononiensis L. — EUROPEAN PART: U. Dnp. (Smolensk Region: Dukhovshchina; Orel Region; Kiev), M. Dnp. (Kursk Region), Transv. (Tatar ASSR: Chistopol'), L. Don (Saratov Region: Balashov), Crim. (Ai-Petrinskaya Yaila,[1] Planerskoe); CAUCASUS: Cisc. (Ordzhonikidze, Voroshilovsk, Mt. Mashuk), E Transc. (Azerbaijan: (Geokchai).

On Campanula macrochlamys Boiss. et Huet. — CAUCASUS: Transc. (according to Voronov).

On Campanula glomerata L. — EUROPEAN PART: Kar.-Lap. (Karelian ASSR), Dv.-Pech. (Arkhangel'sk Region: Bel'sk), Lad.-Ilm. (Leningrad
309 Region), Balt. (Lithuanian SSR, Estonian SSR), U. V. (Kalinin, Moscow, and
Ivanovo regions, Vladimir), V.-Kama (Sverdlovsk Region: Krasnoufimsk), U. Dnp. (Smolensk Region, Belorussian SSR); U. Dns. (Ternopol' Region);

1 [Yaila = monoclinal limestone plateau dissected by Karst valleys.]

W SIBERIA: Ob (Eniseisk), Irt. and Alt. (Altai); E SIBERIA: Ang.-Say. (Balagansk, Minusinsk), Dau. (Buryat-Mongol ASSR: Kyakhta).

On Campanula cervicaria L. — EUROPEAN PART: Kar.-Lap. (Karelian ASSR), V.-Kama (Sverdlovsk Region: Krasnoufimsk), V.-Don (Lipetsk Region: Lebedyan), Transv. (Chkalov Region: Buguruslan); W SIBERIA: Ob (Tobol'sk, Tara, Novosibirsk, Tomsk); E SIBERIA: Ang.-Say. (Irkutsk; Nizhneudinsk).

On Campanula lactiflora M. B. — CAUCASUS: E Transc. (Georgian SSR: Bakuriani).

On Campanula persicifolia L.—EUROPEAN PART: Kar.-Lap. (Karelian ASSR), Dv.-Pech. (Arkhangel'sk Region: Kargopol'), Lad.-Ilm. (Leningrad Region), U. V. (Moscow Region), V.-Don (Voronezh and Tambov regions), Transv. (Tatar ASSR: Menzelinsk), U. Dns. (Ternopol' Region); CAUCASUS: Transc. (Ordzhonikidze Territory: Voroshilovsk).

On Campanula patula L. — EUROPEAN PART: Kar.-Lap. (Karelian ASSR), Dv.-Pech. (Vologda), Lad.-Ilm. (Leningrad Region), Balt. (Lithuanian SSR), U. V. (Kalinin, Moscow, Smolensk, and Ivanovo regions), V.-Kama (Kirov Region, Tatar ASSR, Molotov Region), U. Dns. (Lvov Region), M. Dnp. (Chernigov Region: Priluki), V.-Don (Voronezh Region).

On Campanula sp. — EUROPEAN PART: U. Dns. (Ternopol' Region).

On Symphyandra pendula A. DC. — CAUCASUS: Transc. (Ordzhonikidze Territory: Pyatigorsk).

On Symphyandra pendula var. transcaucasica S. et Lév. — CAUCASUS: W Transc. (Abkhaz ASSR: Kodor River).

On Symphyandra armena A.DC — CAUCASUS: E Transc. (Georgian SSR: Tbilisi (Botanical Garden)); Azerbaijan SSR: Kirovabad, Mt. Koshkar-Dag.).

On Adenophora marsupiiflora Fisch. (incl. A. gmelini Fisch.) — E SIBERIA: Ang.-Say. (Minusinsk, Buryat-Mongol ASSR: Kyakhta).

On Adenophora coronopifolia Fisch. — FAR EAST: Ze.-Bu. (Blagoveshchensk).

On Adenophora verticillata Fisch. — E SIBERIA: Dau. (Nerchinsk (Nerchinskii Zavod)); FAR EAST: Uss. (Maritime Territory).

On Adenophora latifolia Fisch. — E SIBERIA: Ang.-Say. (Sayan Mountains); FAR EAST: Ze.-Bu. (Amur Region), Uss. (Maritime Territory).

On Adenophora denticulata Fisch. — W SIBERIA: Ob (Eniseisk); E SIBERIA: Dau. (Nerchinsk).

On Adenophora liliifolia (incl. A. lamarckii Fisch.). — EUROPEAN PART: V.-Kama (Kirov Region: Omutninsk), V.-Don (Voronezh Region, Syzran), Transv. (Bashkir ASSR: Belebei; Tatar ASSR: Chistopol'; Molotov Region; Chkalov Region: Buguruslan; Sverdlovsk Region, Krasnoufimsk), L. Don (Balashov), Urals (Verkhotur'e); E SIBERIA: Ob (Tomsk, Krasnoyarsk), U. Tob. (Chelyabinsk), Irt. (Kazakh SSR: Kokchetav, Karkaralinsk), Alt. (Altai); E SIBERIA: Ang.-Say. (Sayan Mts.).

On Phyteuma spicatum L. — EUROPEAN PART: U. Dns. (Drogobych Region).

On Lobelia inflata L. (cult.). — EUROPEAN PART: Lad.-Ilm. (Leningrad: Botanical Institute AN USSR), U. Dnp. (Mogilev).

310 The biology of the fungus was studied by many authors. Connection with the aecia on Pinus was established for the majority of forms parasitic on plants of the family Campanulaceae. The pathogenicity of the aecial stage was not elucidated; it is probably insignificant.

17. Coleosporium horianum P. Henn., Hedwigia, XL, 1901, S. (25); Sacc., Sylloge, XVI, 1888, p. 318; Syd., Monogr. Ured. III, 1915, p. 634; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 353.

Spermagonia and aecia unknown.

Uredia hypophyllous, scattered or loosely grouped, small, 0.1 —0.3 mm in diameter, orange-colored. Urediospores, globoid, ovoid, or ellipsoid, densely verrucolose, 17 — 25 × 12 — 19 μ; walls colorless, 1 μ thick; contents orange-colored.

Telia hypophyllous, scattered or grouped, frequently coalescent, 0.5 —1.0 mm in diameter. Teliospores oblong, 50 — 70 × 17 — 30 μ, strongly thickened at apex (15 — 30 μ) (Figure 107).

On species of Codonopsis in eastern Asia (in the USSR: Maritime Territory; Manchuria; Korea; Japan).

On Codonopsis ussuriensis Hemsley — FAR EAST: Uss. (Maritime Territory).

On Codonopsis lanceolata B. et A. — FAR EAST: Uss. (Maritime Territory: Mongugai River).

(311)

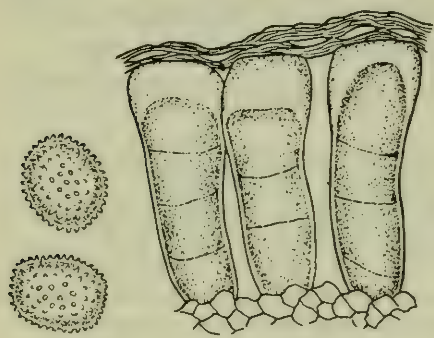


FIGURE 107. Coleosporium horianum P. Henn. on Codonopsis lanceolata B. et H.:

1 — urediospores; 2 — teliospores; × 600. (Orig.)

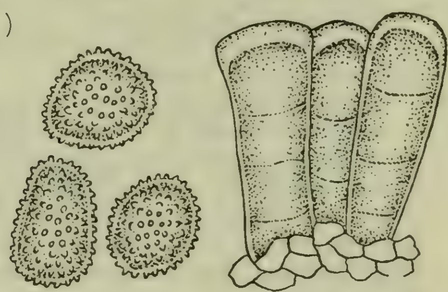


FIGURE 108. Coleosporium asterum (Diet.) Syd. on Aster scaber Thunb.:

1 — urediospores; 2 — teliospores; × 600. (Orig.)

On Compositae

18. Coleosporium asterum (Diet.) Syd., Ann. mycol. XII, 1914, p. 109; Syd., Monogr. Ured. III, 1915, p. 600; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 378.

Syn.: Stichopsora asterum Diet., Engler's Bot. Jahrb. XXVII, 1899, S. 566; Sacc., Sylloge, XVI, 1902, p. 318.

Peridermium pini-densiflorae P. Henn., Engler's Bot. Jahrb. XXVIII, 1906, S. 263; Sacc., Sylloge, XVI, 1902, p. 349.

Coleosporium pini-asteris Orish., Bot. Mag. Tokyo, XXIV, 1910, p. 4.

Coleosporium solidaginis (Schw.) Thüm., Bull. Torrey Bot. Club, VI, 1878, p. 216, pr. p.; Arth., N. Amer. Fl. VII, 1907, p. 90; 1925, p. 655; Manual Rusts U. S. a. Canada, 1934, p. 43, fig. 62, pr. p.

Biol. Orishimo, l. c., 1910; Hirats., Bot. Mag. Tokyo, XLVIII, 571, 1934, p. 465; Clinton, Science, II, XXV, 1907, p. 289, pr. p.; Hedgcock, Phytopathology, VI, 1916, p. 65. See Coleosporium solidaginis (Schw.) Thüm.

Spermagonia scattered or in rows, brown, immersed, flattened-conical, 0.2 — 2.5 mm wide. Spermatia 1.0 — 1.5 × 1.0 μ.

Aecia in rows, toothlike, 0.6 — 1.4 mm high, 0.5 — 1.5 mm long, 0.3 — 1.0 mm wide. Aeciospores ovoid, prismatic or nodose, orange-colored,
311 22.5 — 35 × 14 — 22.5 μ (on an average, 32.5 × 22 μ); walls colorless, verruculose, 1 — 2 mm thick.

Uredia hypophyllous, in rings or irregularly grouped, oval or circular, occasionally of irregular shape, 0.2 — 0.5 across, orange-colored. Urediospores subgloboid, ellipsoid, 22 — 30 × 16 — 22 μ; walls colorless, 1 — 2 μ thick, densely verrucose.

Telia scattered or in circular groups, round, 0.3 — 0.6 mm in diameter, orange-colored. Teliospores cylindrical, clavate, 60 — 100 × 16 — 25 μ, greatly thickened at apex, 25 — 40 μ (Figure 108).

Aecia on **Pinus densiflora** S. et Z., including **P. funebris** Kom., which in the Soviet Far East apparently represents the host of the aecial stage. Uredio- and teliospores on species of Aster (also on **Callistephus**, etc. ?).

The fungus is encountered in eastern Asia (North America — see **Coleosporium solidaginis**).

On **Aster amellus** L. — FAR EAST: Uss. (Maritime Territory: Okeanskaya (II), Voroshilov).

On **Aster scaber** Thunb. — FAR EAST: Uss. (Maritime Territory).

On **Aster glehni** Fr. Schm. — FAR EAST: Sakh. (S Sakhalin).

Orishimo successfully infected Aster scaber with aeciospores from **Pinus densiflora**, and vice versa. Hiratsuka obtained infections of **Pinus densiflora** by sowing germinating teliospores from Aster leiophyllus Franch. et Sav. (= A. trinervis Roxb. var. **adjustus** Maxim.). Reverse sowing (aeciospores) infected **Aster leiophyllus**, but failed to infect A. scaber Thunb., **Solidago virgauera** L., **Petasites japonicus** S. et Z., etc. The experiments conducted by Orishimo, Clinton, Hiratsuka, and others established the existence of biological forms of the fungus strongly adapted to definite hosts.

19. **Coleosporium eupatorii** Arth., Bull. Torrey Bot. Club, XXXIII, 1906, p. 31; Arth., N. Amer. Fl. VII, 1907, p. 90; 1924; p. 654; Sacc., Sylloge, XXI, 1912, p. 719; Syd., Monogr. Ured. III, 1915, p. 607.

Biol. Hiratsuka, Trans. Sapporo Nat. Hist. Soc. IX, 2, 1927, p. 218 — 219.

Spermagonia subepidermal, 0.57 — 0.76 mm long, 0.28 — 0.6 mm wide, 56 — 65 μ high.

Aecia hypophyllous, in rows parallel to midrib, 0.8 — 0.3 mm long, 1.0 — 1.8 mm high, pseudoperidia delicate, colorless; peridial cells from ovoid to ellipsoid, 50 — 72 × 23 — 34 μ, occasionally pointed at one end or at both ends, slightly overlapping, easily detaching; lateral walls 5.4 — 10.0 μ thick, inner wall sparingly verrucose, with low irregular lineate
312 contours. Aeciospores oblong, 23 — 32 × 18 — 23 μ; wall 1.8 — 3.0 μ thick, verrucose.

Uredia hypophyllous, scattered, small, round, 0.2 — 0.3 mm across, pulverulent, brownish-yellow and light yellow. Urediospores globoid, ellipsoid,

or ovoid, $18-27 \times 15-21\,\mu$; walls verrucose, colorless, $1.5-2.0\,\mu$ thick; contents from pale yellow to colorless.

Telia hypophyllous, scattered or in groups, small, round, 0.2–0.8 mm in diameter, from reddish-yellow to orange-colored. Teliospores cylindrical or prismatic, $50-81 \times 14-21\,\mu$ with apical thickenings up to $7-14\,\mu$, colorless; walls thin; contents to pale yellow (according to Hiratsuka).

Aecia on needles of **Pinus koraiensis** Sieb. et Zucc. (and on other species ?); uredio- and teliospores on species of **Eupatorium** in Japan, Central and South America, Cuba.

In experiments carried out by Hiratsuka aeciospores from **Pinus koraiensis** infected **Eupatorium sachalinense** Thunb.

The fungus may be found also in the Soviet Far East.

20. **Coleosporium heteropappi** (P. Henn.) Tranz., Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 378, 355.

Syn.: **Uredo heteropappi** P. Henn., Engler's Bot. Jahrb. XXXIV, 1904, S. 597; Sacc., Sylloge, XXI, 1912, p. 728; Syd., Monogr. Ured. IV, 1924, p. 394.

Aecia unknown.

Uredia hypophyllous, scattered, round, 0.5 mm in diameter. Urediospores globoid, ovoid, or ellipsoid, $20-26 \times 12-22\,\mu$; walls densely verrucose, $1.5-2.0\,\mu$ thick (Figure 109).

Telia unknown.

On **Heteropappus** in the USSR (Far East) and in Japan; the fungus is probably related to **Coleosporium asterum**.

On **Heteropappus hispidus** Less. — FAR EAST: Uss. (Maritime Territory: Okeanskaya, Novokievskoe, Voroshilov).

(313)

FIGURE 109. Coleosporium heteropappi (P.Henn.) Tranz. on Heteropappus hispidus Less. Urediospores, × 600. (Orig.)

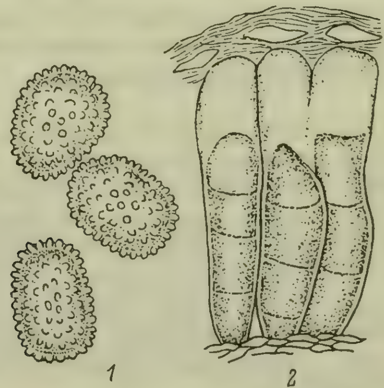


FIGURE 110. Coleosporium solidaginis (Schw.) Thüm. on Solidago sp.:

1 — urediospores; 2 — teliospores; × 600. (Orig.)

21. Coleosporium solidaginis (Schw.) Thüm., Bull. Torrey Bot. Club, VI, 1878, p. 216; Sacc., Sylloge, VII, 1888, p. 756; Arth., N. Amer. Fl. VII, 1907, p. 90; 1925, p. 655; 1927, p. 814, 816; Manual Rusts U. S. a. Canada, 1934, p. 43, fig. 62, pr. p. ; Syd., Monogr. Ured. III, 1915, p. 619; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 378.

Syn.: Uredo solidaginis Schw., Schr. Nat. Ges. Leipzig, I, 1822, S. 70.

Stichopsora solidaginis Diet., Hedwigia, XLII, 1903, S. 181.

Peridermium acicolum Underw. et Earle, Bull. Torrey Bot. Club, XXIII, 1896, p. 400.

Coleosporium heterothecae Hedgc. et Hunter, Mycoligia, XXV, 1933, p. 396.

Biol. Clinton, Science II, XXV, 1907, p. 289; Weir a. Hubert,
313 Phytopathology, VI, 1916, p. 65; Hedgcock a. Hunter, l. c.

Spermagonia amphigenous, scattered or in rows, 0.5 —1.0 mm long, about 100 μ high.

Aecia amphigenous, scattered or in rows, 0.5 — 2.0 mm long, 0.5 —2.0 mm high, on which patches, slightly compressed, with large peridia. Aeciospores ellipsoid or prismatic, densely verrucose, $28-42 \times 18-25\,\mu$; wall $3-5\,\mu$ thick.

Uredia hypophyllous, rarely epiphyllous, on yellowed patches, scattered or loosely grouped, small, round, 0.3 — 0.6 mm in diameter, orange-yellow or pale yellow: urediospores globoid, ovoid, or ellipsoid, densely verrucose, $20-30 \times 17-22\,\mu$; walls colorless, $1-2\,\mu$ thick.

Telia hypophyllous, scattered or in groups, coalescent, small, 0.3 — 0.5 mm in diameter, orange-yellow. Teliospores cylindrical or clavate, $65-110 \times 16-26\,\mu$, apically rounded and thickened up to $25-40\,\mu$, smooth (Figure 110).

Aecia on species of Pinus, uredio- and teliospores on species of Solidago (according to Arthur also on other genera of the tribe Astereae in North America).

Coleosporium on Solidago is absent in the USSR. Arthur has united Coleosporium asterum with C. solidaginis. The two species are very close but adapted to different hosts. The biology of the fungus was studied by Clinton and other scientists.

22. Coleosporium inulae (Kunze) Rabenh., Bot. Ztg. IX, 1851, S. 455; Fischer, Ured. Schweiz, 1904, S. 448, Fig. 300; Hariot, Uréd., 1908, p. 272; Liro, Ured. Fenn., 1908, p. 478; Bubák, Rostpilze Böhmens, 1908, S. 178; Migula, Kryptog.-Fl. Deutschl. III, 1, 1910, S. 463; Sacc., Sylloge, XX, 1912, p. 721; Klebahn, Kryptogfl. M. Brandb. Va, 1914, S. 744, Fig. M8 (p. 746); Trotter, Fl. Crypt. Ital. Ured., 1914, p. 369, fig. 91; Syd., Monogr. Ured. III, 1915, p. 609; Fragoso Fl. Iber. Ured. II, 1925, p. 324, fig. 151; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 378, 356.

Syn.: Uredo inulae Kunze in Klotzsch. Rabenhorst, Herb. mycol. I, No. 589, 1860.

Uredo inulae Fuckel, Symb. mycol., 1869, p. 44.

Coleosporium inulae Ed. Fisch., Mitt. Naturf. Ges. Bern, Sitzung V, 28 April 1894, S. 2.

Peridermium klebahni Ed. Fisch., Mitt. Naturf. Ges. Bern, Sitzung V, 28 April 1894, S. 2.

Biol. Fischer, l. c., 1894; Bull. Soc. bot. France, XLI, 1894, p. CLXIX; Entwicklungsgesch. Untersuch. über Rostpilze, I, 1, 1898, S. 95; Klebahn, Ztschr. Pflanzenkr. XII, 1902, S. 31; Wirtswechs. Rostpilze, 1904, 314 S. 363; Mayor, Bull. Soc. Neuchât. sci. natur. XLVIII, 1923, p. 385.

Spermagonia mainly epiphyllous, 0.5 — 0.75 mm long, 0.25 mm wide.

Aecia amphigenous, scattered. Aeciospores mostly prismatic, some globoid or ovoid, $20-40 \times 13-18\,\mu$; walls colorless, $3.0-3.5\,\mu$, thick, densely verrucose; contents orange-colored.

Uredia hypophyllous, on small yellowed patches, round or oblong, small, up to 0.5 mm across, orange-colored. Urediospores mostly oblong-elliptical or oblong, frequently slightly angular, $19-30 \times 12-15\,\mu$; walls colorless, about $1.5\,\mu$ thick, densely verruculose.

Telia hypophyllous, small, round, yellow, later reddish. Teliospores prismatic, $90-100 \times 16-22\,\mu$; walls colorless, strongly thickened at the apex $(35-40\,\mu)$ (Figure 111).

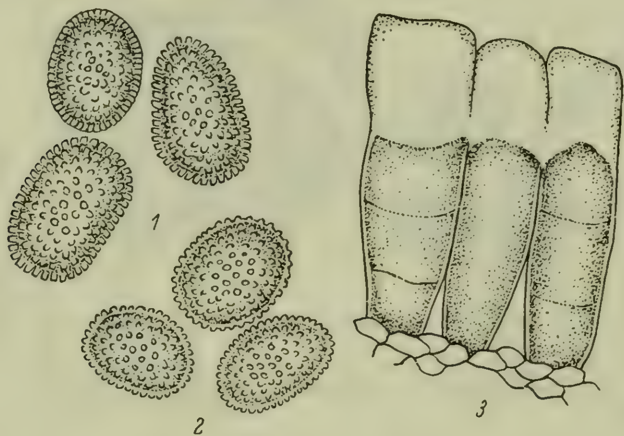


FIGURE 111. **Coleosporium inulae** (Kunze) Rabenh.:

1 — aeciospores on **Pinus silvestris** L.; 2 — urediospores; 3 — teliospores on **Inula salicina** L.; × 600. (Orig.)

Aecia on Pinus silvestris, uredio- and teliospores on species of Inula.

General distribution: Europe, Asia.

On **Inula helenium** L. — EUROPEAN PART: Balt. (Latvian SSR, Lithuanian SSR), U. V. (Moscow, Ivanovo), M. Dnp. (Kiev), V.-Don. (Syzran), Transv. (Pugachev), L. Don. (Saratov); CAUCASUS: Cisc. (Ordzhonikidze, Pyatigorsk), W Transc. (Krasnodar Territory: Tuapse; Abkhaz ASSR: Sukhumi), E Transc. (Azerbaijan SSR: Kuban District).

On **Inula ensifolia** L. — EUROPEAN PART: Crim.; CAUCASUS: Cisc. (Kislovodsk).

On **Inula germanica** L. — EUROPEAN PART: Crim.

On **Inula salicina** L. — EUROPEAN PART: Balt. (Lithuanian SSR), U. V. (Moscow Region: Mikhailovskoe), V.-Kama (Kirov Region: Malmyzh, Krasnoufimak), L. Don (Saratov), Urals (Kyshtymskii zavod); W SIBERIA:

Ob (Tobol'sk, Tomsk), Irt. (Kazakh SSR, Omsk), Alt. (Altai); E SIBERIA: Ang.-Say. (Minusinsk); FAR EAST: Ze.-Bu. (Blagoveshchensk).

315 On **Inula glandulosa** Willd. — CAUCASUS: W Transc. (Abkhaz ASSR).

On **Inula cordata** Boiss. — CAUCASUS: E Transc. (Georgian SSR: Likani).

Aecial host established by Fischer in experimental cultures, and confirmed by Klebahn and Mayor.

23. **Coleosporium carpesii** Sacc., Riv. Acc. Padova, XXIV, 1874, p. 208; Sylloge, VII, 1888, p. 753; Trotter, Fl. Crypt. Ital. Ured., 1914, p. 369; Syd., Monogr. Ured. III, 1915, p. 602; Siemaszko, Mater. po mikol. i fitopatol. III, I, 1917, fig. 85; Fragoso, Fl. Iber. Ured. II, 1925, p. 323; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 378.

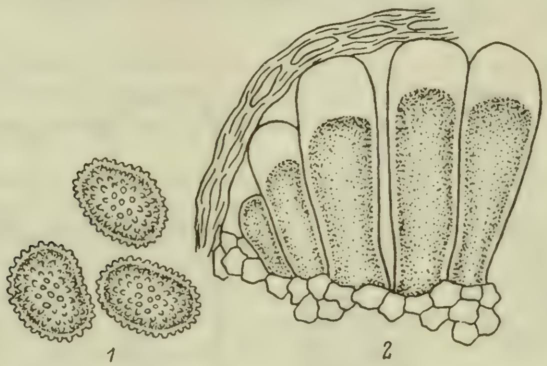


FIGURE 112. Coleosporium carpesii Sacc. on Carpesium cernuum L.:

1 — urediospores; 2 — teliospores; × 600. (Orig.)

Syn.: Coleosporium sonchi f. carpesii Sacc., Sylloge, VII, 1888, p. 753.

Coleosporium carpesii Diet., Engler's Bot. Jahrb. XXXIV, 1905, S. 588.

Spermagonia and aecia unknown.

Uredia hypophyllous, scattered, small, 0.3 — 0.5 mm in diameter, orange-colored. Urediospores globoid, ovoid, or ellipsoid, 18 — 28 × 16 — 23 μ; walls colorless, about 1.5 μ thick, densely verrucose.

Telia hypophyllous, small, red. Teliospores up to 160 μ long, 18 — 26 μ wide; walls at apex thickened up to 24 μ (Figure 112).

On species of **Carpesium** in the USSR (Transcaucasia), Italy, Spain, and Japan.

On **Carpesium cernuum** L. — CAUCASUS: W Transc. (Sochi).

On **Carpesium abrotanoides** L. — CAUCASUS: W Transc. (Sukhumi, Tsebel'da).

24. **Coleosporium telekiae** Thüm., Fungi austr. No. 850, 1873; Österr. bot. Ztschr. XXVI, 1876, S. 21; Sacc., Sylloge, VII, 1888, p. 753; Syd., Monogr. Ured. III, 1815, p. 623; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 379.

Syn.: **Coleosporium telekiae** Bubák, supplement to "Novénytani Közlemenyek," 1907, 4, p. 102.

Spermagonia and aecia unknown.

316 Uredia hypophyllous, on yellowish or brownish patches, scattered or in irregular groups, 0.3 — 0.6 mm across, orange-colored. Urediospores globoid, ellipsoid, ovoid, or prismatic, $18-28 \times 16-22\,\mu$; walls colorless, $1.0-1.5\,\mu$ thick, densely verrucose.

Telia hypophyllous, scattered or irregularly grouped, round, small, 0.4 — 0.6 mm across, orange-colored. Teliospores cylindrical, $80-130 \times 19-25\,\mu$, extremely thickened at apex ($25-35\,\mu$) (Figure 113).

On Buphthalmum (Telekia) speciosum in SE Europe and the Caucasus.

On Buphthalmum speciosum Schreb. (= Telekia speciosa Baumg.) — EUROPEAN PART: Balt. (Latvian SSR); CAUCASUS: W Transc. (Abkhaz ASSR: Sukhumi), E Transc. (Georgian SSR: Gori).

(317)

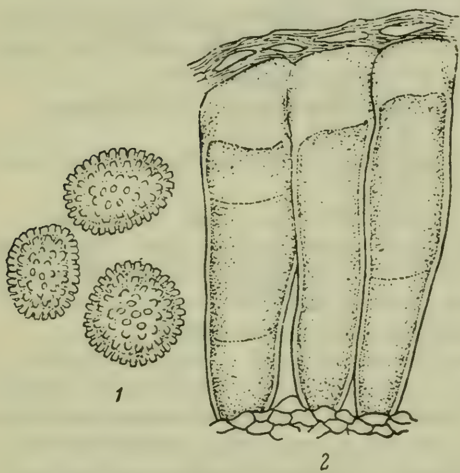


FIGURE 113. **Coleosporium telekiae** Thum. on **Buphthalmum speciosum** Schreb.:

1 — urediospores; 2 — teliospores; × 600. (Orig.)

FIGURE 114. **Coleosporium tussilaginis** (Pers.) Lév. on **Tussilago farfara** L.:

1 — urediospores; 2 — teliospores; × 600. (Orig.)

25. **Coleosporium tussilaginis** (Pers.) Lév., Ann. sci. natur. III, sér. VIII, 1847, p. 373, Dict. hist. natur., article Urédinées, 1848, p. 786; emend. Klebahn, Ztschr. Pflanzenkr. II, 1892, S. 269; Fischer, Ured. Schweiz, 1904, S. 449; Bubák, Rostpilze Böhmens, 1908, S. 179; Liro, Ured. Fenn., 1908, p. 480; Hariot, Uréd., 1908, p. 275, fig. 38; Migula, Kryptog.-Fl. Deutschl. III, 1, 1910, S. 463, Tab. XB, Fig. 4; Sacc., Sylloge, XXI, 1912, p. 720; Grove, Brit. Rust Fungi, 1913, p. 322, fig. 243; Klebahn, Kryptogfl. M. Brandb. Va, 1914, S. 741, Fig. M5 (p. 746); Trotter, Fl. Crypt. Ital. Ured., 1914, p. 449; Syd., Monogr. Ured. III, 1915, p. 624; Fragoso, Fl. Iber. Ured. II, 1925, p. 334; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 379.

Syn.: **Uredo tussilaginis** Pers., Syn. fung., 1801, p. 218.

Uredo tussilaginis Mart., Prodr. fl. Mosqu., ed. II, 1817, p. 218.

Peridermium Plowrightii Kleb., Ztschr. Pflanzenkr. II, 1892, S. 272.

Biol. Klebahn, Ztschr. Pflanzenkr. II, 1892, S. 269; IV, 1894, S. 7; V, 1895, S. 72; XXIV, 1914, S. 17; Wirtswechs. Rostpilze, 1904, S. 363; Fischer, Entwicklungsgesch. Untersuch. über Rostpilze, I, 1, 1898, S. 103; Wagner, Ztschr. Pflanzenkr. VIII, 1898, S. 258, 345; Plowright, Gard. Chron. XXV, 1899, p. 415; Mayor, Bull. Soc. Neuchât. sci. natur. XLVIII, p. 386; Vanin, Lesn. fitopatol., 1948, p. 112.

Spermagonia epiphyllous, rarely hypophyllous, 0.5 mm long, up to 0.4 mm wide.

Aecia hypophyllous, 1 — 2 mm high. Aeciospores ovoid or globoid, rarely elongate, 15 — 35 (mostly 15 — 24) × 15 — 24 μ; walls colorless, 2.0 — 2.5 μ thick, verruculose.

317 Uredia hypophyllous, small, about 0.5 mm, scattered or gregarious, orange-yellow. Urediospores globoid or slightly elongate, 21 — 32 × 16 — 22 μ; walls about 1.5 μ thick, colorless, verrucose.

Telia hypophyllous, scattered or gregarious, often coalescent in crusts, bright red. Teliospores clavoid-cylindrical, 60 — 80 (up to 140) × 15 — 28 μ; walls strongly thickened at apex, up to 18 — 21 μ (Figure 114).

Aecia on Pinus silvestris L., uredio- and teliospores on Tussilago farfara L.; common.

General distribution: Europe, Asia: West Siberia as far as Altai (and in the south as far as Tien Shan?).

On Tussilago farfara L. — EUROPEAN PART: Kar.-Lap. (Karelian ASSR), Dv.-Pech. (Arkhangel'sk and Vologda regions), Lad.-Ilm. (Leningrad Region), Balt. (Estonian SSR, Latvian SSR, Lithuanian SSR), U. V. (Moscow, Kalinin, and Ivanovo regions), V.-Kama (Gorkii and Kirov regions, Tatar ASSR), U. Dnp. (Smolensk and Orel regions, Belorussian SSR), U. Dns. (Lvov Region), M. Dnp. (Kursk Region, Ukrainian SSR), V.-Don (Voronezh and Kuibyshev regions), L. Don (Saratov Region), Urals (Sverdlovsk Region), Crim.; CAUCASUS: Georgian SSR: W SIBERIA: Ob (Sverdlovsk and Omsk regions), Irt. and Alt. The biology of the fungus was thoroughly studied by Klebahn, Fischer, and other mycologists. In experiments carried out by Klebahn (1914, pp. 14 — 18) urediospores from Tussilago farfara proved infective for Schizanthus grahami Gill. and Tropaeolum minus L.; and noninfective for Tropaeolum majus L. The results of the experiments were instrumental in the elucidation of fungal transfer onto chance hosts (see Coleosporium vagans).

The pathogenicity of the aecial stage for species of Pinus was not sufficiently studied. For the control of the fungus in nurseries Vanin (1948) recommends spraying with Bordeaux solution.

26. **Coleosporium petasitis** (DC) Lév., Ann. sci. natur. III, sér. VIII, 1847, p. 373; Dict. Hist. natur., article Urédineés, 1848, p. 786; Fischer, Ured. Schweiz, 1904, S. 450; Bubák, Rostpilze Böhmens, 1908, S. 179; Liro, Ured. Fenn., 1908, p. 481; Hariot, Uréd., 1908, p. 273; Migula, Kryptog.-Fl. Deutschl. III, 1, 1910, S. 463; Grove, Brit. Rust Fungi, 1913, p. 323; Klebahn, Kryptogfl. M. Brandb. Va. 1914, S. 743, Fig. M6 (p. 746); Trotter, Fl. Crypt. Ital. Ured., 1914, p. 371; Syd., Monogr. Ured. III, 1915, p. 613; Fragoso, Fl. Iber. Ured. II, 1925, p. 327; Sacc., Sylloge, XXIII, 1925, p. 857; Tranzschel, Consp. Ured. USSR, Moscow, 1939, p. 379.

318 Syn.: Uredo petasitis DC, Fl. franç. II, 1805, p. 236.

Coleosporium petasitis (petasitis) de Bary in lit.

Peridermium Boudieri Ed. Fisch., Bull. Soc. bot. France, XLI, 1894, p. CLXXI.

Peridermium Dietelii Wagn., Ztschr. Pflanzenkr. VI, 1896, S. 10.

Biol. Fischer, l. c., 1894; Entwicklungsgesch. Untersuch. über Rostpilze, 1898, S. 105; Wagner, Ztschr. Pflanzenkr. VI, 1896, S. 10; Klebahn, Wirtswechs. Rostpilze, 1904, S. 364; Mayor, Bull. Soc. Neuchât. sci. natur. XLVIII, 1923, p. 386; LXIV, 1939, p. 16.

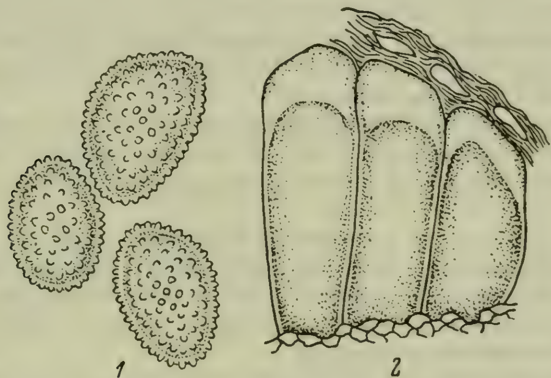


FIGURE 115. Coleosporium petasitis (DC) Lév. on Petasites tomentosus (Ehrh.) DC:

1 — urediospores; 2 — teliospores; × 600. (Orig.)

Spermagonia mainly epiphyllous, 0.5 — 1.0 mm long, 0.3 — 0.5 mm wide, 80 — 100 μ high.

Aecia amphigenous, 1.0 — 2.5 mm long, 1.0 — 1.5 mm high. Aeciospores globoid, ovoid, or ellipsoid, 21 — 38 × 18 — 28 μ; walls colorless, 3 — 4 μ thick, densely verrucose.

Uredia hypophyllous, scattered or loosely grouped, small, 0.4 — 0.7 mm across, round, orange-colored. Urediospores ellipsoid or ovoid, 21 — 32 (42) × 14 — 21 μ; walls about 1.5 μ thick, colorless, verrucose.

Telia small, in small groups or extending over considerable areas, red. Teliospores cylindrical, 60 — 100 × 18 — 24 μ; walls thickened at apex up to 17 — 20 μ (Figure 115).

Aecia on Pinus silvestris L., also on P. montana Mill.; uredio- and teliospores on species of Petasites.

The fungus is widespread in Europe (including the Caucasus) and Asia (West Siberia and Japan).

On Petasites officinalis Moench. — EUROPEAN PART: Balt. (Lithuanian SSR); CAUCASUS: Cisc. (Ordzhonikidze Territory: Pyatigorsk), Dag. (Dagestan ASSR), E Transc. (Georgian SSR: Borzhomi).

On Petasites tomentosus (Ehrh.) DC (= P. spurius Rchb.) — EUROPEAN PART: Dv.-Pech. (Arkhangel'sk Region: Dvina River in former Shenkursk

County), Lad.-Ilm. (Leningrad Region: Lovat River), Balt. (Latvian SSR, Lithuanian SSR), U. V. (Moscow Region, Ryazan Region: Kasimov; Yaroslavl'), V.-Kama (Gorkii Region: Vasil'sursk; Kirov Region; Molotov; Tatar ASSR: Kazan), M. Dnp. (Kursk Region; Poltava), V.-Don (Voronezh
319 Region; Tula Region: Aleksin; Penza; Kharkov), Transv. (Kuibyshev Region: Kinel' River; Bashkir ASSR: Dema River in former Belebei County; Chkalov Region: Buzuluk), L. Don (Saratov Region: Pady on the Khoper River; Voroshilovgrad [Lugansk] Region: Starobel'sk).

On Petasites heterophyllus Kihlm. (= P. laevigatum Rchb. subsp. heterophyllus Cajander) — EUROPEAN PART: Dv.-Pech. (Arkhangel'sk Region: Ust-Konsa on the banks of the Onega and Malaya Onega rivers).

On Petasites frigidus L. (= Nardosmia frigida (L.) Hook) — EUROPEAN PART: Kar.-Lap. (Karelian ASSR: Petrozavodsk, Vyazemskoe village); W SIBERIA: Ob (Tobol'sk, Eniseisk).

Production of aecia on Pinus silvestris was experimentally proved by Fischer and other mycologists. Mayor (France) obtained urediospores on Petasites albus Gärth. upon sowing aeciospores from Pinus montana Mill.

27. **Coleosporium doronici** Namysl., Prodr. Ured. Galic. et Bucov. in Sprawozdan. Komisyi fizyograf. Akad. Umiejetnosci w Krakowie, XLV, 1911, p. 125; Syd., Monogr. III, 1915, p. 604; Sacc., Sylloge, XXIII, 1925, p. 856; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 379, 362.

Spermagonia and aecia unknown.

Uredia hypophyllous, scattered or in small groups, round, small, 0.3 — 0.5 mm in diameter, orange-colored. Urediospores usually globoid or subgloboid, rarely ellipsoid or ovoid, $22-32 \times 17-27\,\mu$; walls thin, about $1.5\,\mu$ thick, rather coarsely verrucose.

Telia hypophyllous, scattered or, more often in small groups, small, round, frequently coalescent, 0.4 — 0.7 mm in diameter, orange-colored. Teliospores cylindrical, $65-90 \times 18-25\,\mu$, at the apex strongly thickened ($20-30\,\mu$).

Uredio- and teliospores on Doronicum in the W Ukraine.

On Doronicum austriacum Jack. — EUROPEAN PART: U. Dns. (Stanislav Region, the Carpathians).

28. **Coleosporium senecionis** (Schum.) Fries, Summa Veget. Scand., 1849, p. 512, pr. p.; Sacc.; Sylloge, VII, 1888, p. 751; XXIII, 1925, p. 858; Fischer, Ured. Schweiz, 1904, S.451; Bubák, Rostpilze Böhmens, 1908, S. 180, Fig. 43; Liro, Ured. Fenn., 1908, p. 483; Hariot, Uréd., 1908, p. 274, fig. 40; Migula, Kryptog.-Fl. Deutschl. III, 1, 1910, S. 464, Taf. X, Fig. 2, XB, Fig. 3; Grove, Brit. Rust Fungi, 1913, p. 320, fig. 241; Klebahn, Kryptogfl. M. Brandb. Va, 1914, S. 745, Fig. M 9 (p. 746); Trotter, Fl. Crypt. Ital. Ured., 1914, p. 371, fig. 28a, 92; Syd., Monogr. Ured. III, 1915, p. 615; Fragoso, Fl. Iber. Ured. II, 1925, p. 328, fig. 153 — 165; Arth., N. Amer. Fl. VII, 1907; Manual Rusts U. S. a. Canada, 1934, p. 49, fig. 43.

Syn.: Uredo farinosa Pers. var senecionis Pers., Syn. fung., 1801, p. 218.

Uredo senecionis Schum., Pl. Saell. II, 1803, p. 229; Martius, Prodr. fl. Mosqu., ed. II, 1817, p. 230.

Coleosporium subalpinum Wagn., Ztschr. Pflanzenkr. VI, 1896, S. 12.

Aecidium oblongisporium Karst., Mycol. Fenn. IV, 1879, p. 45, pr. p.

Peridermium oblongisporium Fuckel. Symb. mycol., 1869, p. 43, pr. p.; Thümen, Mitt. forstl. Versuchswes. Österr. II, III, 1881, S. 315; Klebahn, Hedwigia, XXIX, 1890.

320 Peridermium Kriegerii Wagn., Ztschr. Pflanzenkr. VI, 1896, S. 12.

B i o l. Wolff, Bot. Ztg. XXXII, 1874, S. 183; Landwirtsch. Jahrb. VI, 1877, S. 739; Rostrup, Tidsskr. Skovbrug, II, 1877, p. 159; Cornu, Bull. Soc. bot. France, XXVII, 1880, p. 179; Plowright, Grevillea, XI, 1882, p. 52; Hartig, Untersuch. Forstbot. Inst. München, III, 1883, S. 150; Klebahn, Hedwigia, XXIX, 1890, S. 32; Ztschr. Pflanzenkr. II, 1892, S. 265; XXIV, 1914, S. 18; Jahrb. wiss. Bot. XXXV, 1900, S. 692; Wirtswechs. Rostpilze, 1904, S. 358; Fischer, Bull. Soc. bot. France, XLI, 1894, p. CLXX; Entwicklungsgesch. Untersuch. über Rostpilze, I, 1, 1898, S. 101; Mitt. Naturf. Ges. Bern. (1916) 1917, S. 138; Wagner, Ztschr. Pflanzenkr. VI, 1896, S. 10; Treboux, Ann. mycol. X, 1912, p. 306; Mayor, Bull. Soc. Neuchât. sci. natur. LI, 1926, p. 66; Vanin, Lesn. fitopatol., 1948, p. 112.

Spermagonia amphigenous, 0.5 — 1.0 mm long, 0.4 — 0.5 mm wide.

Aecia amphigenous, 1 — 3 mm long, about 0.25 mm wide, 1.5 mm high. Aeciospores elongate or oblong-ovoid, rarely globoid, $20-50 \times 15-25\mu$; walls colorless, $3-4\mu$, coarsely verrucose.

Uredia usually hypophyllous, up to 1 mm in diameter, orange-colored. Urediospores prismatic or ovoid, $22-31 \times 14-20\mu$; walls colorless, verrucose, $1-2\mu$ thick.

Telia hypophyllous and caulicolous, up to 1 mm in diameter, frequently in confluent groups, red. Teliospores cylindrical up to 100μ long, $18-24\mu$ thick; walls strongly thickened at apex, up to 22μ (Figure 116).

Aecia on species of Pinus (P. silvestris L., P. montana Mill., P. austriaca Hoss.); uredio- and teliospores on species of Senecio.

G e n e r a l d i s t r i b u t i o n: Europe, Asia (Siberia, Far East), America.

The species breaks up into forms confined to certain host plants; specialization is apparently not distinguished by consistent stability.

Forma sp. senecionis silvatici Wolff on Senecio silvaticus L., S. viscosus L. and S. vulgaris L. According to Klebahn, it passes, in experimental cultures, onto Tropaeolum minus L. The connection with aecia on Pinus was established by Wolff, Klebahn, Fischer, and others.

Forma sp. senecionis subalpini Wagn. Aecia on Pinus montana Mill., uredio- and teliospores on Senecio subalpinus Koch. The connection with P. montana was established by Wagner.

Forma sp. senecionis doronici Fischer. (Ured. d. Schweiz, 1904, p. 452, as a species) — on Pinus montana Mill. and Senecio doronicum L. Change of hosts was not proved experimentally.

Forma sp. senecionis fuchsii Fischer. Aecia on Pinus silvestris L. and P. montana Mill., uredio- and teliospores on Senecio fuchsii Gm. (Fischer, 1917). Change of hosts was experimentally established.

321 Forma sp. senecionis carpetanum Fragoso, Contrib. Fl. mycol. Guadarrama, Ured., 1914, p. 39, Figs. 8, 9, 10 (Saccardo, Sylloge, XXIII, 1925, p. 858) — on Senecio durieui Gay (var. carpeteni) and S. tournefortii Lapeyr. Urediospores $20-32 \times 18-30\mu$; wall $1.5-2.0\mu$ thick, sparsely echinulate, with 3 — 5 germ pores; teliospores, $90-130 \times 16-30\mu$.

On Pinus — see above.

On Senecio vulgaris L. — EUROPEAN PART: Lad.-Ilm. (Leningrad Region), Balt. (Estonian SSR), U. V. (Moscow Region), M. Dnp. (Ternopol' Region; Uman), V.-Don. (Voronezh), Crim.; CAUCASUS: W Transc. (Krasnodar Territory: Sochi; Abkhaz ASSR: Sukhumi).

On Senecio silvaticus L. — CAUCASUS: W Transc. (Adzhar ASSR: Chakva).

On Senecio vernalis Waldst. et Kit. — EUROPEAN PART: M. Dnp. (Belaya Tserkov).

On Senecio lampsanoides DC — CAUCASUS: E Transc. (Dar'yal (C. A. Meyer, 1829)).

On Senecio argunensis Turcz.— FAR EAST: Manchuria.

On Senecio platyphyllus DC. — CAUCASUS: W Transc. (Abkhaz ASSR), E Transc. (Georgian SSR: Bakuriani).

On Senecio nemorensis L. and on var. octoglossus Koch. — EUROPEAN PART: Dv.-Pech. (Komi ASSR: Pechora), U. Dnp. (Drogobych Region), V.-Kama (Krasnoufimsk), Transv. (Bashkir ASSR: Ufa); CAUCASUS: E Transc. (Georgian SSR: Borzhomi); W SIBERIA: Ob (Tobol'sk, Tomsk), Irt. (Omsk), Alt. (Altai); E SIBERIA: Lena-Kol. (Kirensk), Ang.-Say. (Sayan Mts., Lake Baikal), Dau. (Buryat-Mongol ASSR: Kyakhta); FAR EAST: Uss. (Maritime Territory: Mongugai, Okeanskaya), Sakh. (S Sakhalin, on S. nemorensis L. var. fuchsii Koch; according to Hiratsuka).

On Senecio fuchsii Gm. — EUROPEAN PART: U. Dnp. (Stanislav Region: Chernogory).

On Senecio fluviatilis Wallr. (= S. sarracenicus auct. fl. ross.) — EUROPEAN PART: U. V. (Moscow Region: Mozhaisk); W SIBERIA: Ob (Novosibirsk), Irt. and Alt. (Altai).

On Senecio schwetzowii Korsh. — EUROPEAN PART: L. Don (Novocherkassk (according to Treboux)).

On Senecio macrophyllus M. B. (= S. doria β macrophyllus Schm.) — EUROPEAN PART: L. Don. (Troyanovka, near Rostov-on-Don).

On Senecio pandurifolius C. Koch — CAUCASUS: W Transc. (Ingur River basin).

On Senecio otophorus Max. — FAR EAST: Uss. (Maritime Territory: Maikhe River).

On Senecio palmatus Pall. — FAR EAST: Kamch., Uss. (Maritime Territory: Okeanskaya), Sakh. (S Sakhalin).

On Senecio campester DC (= S. integrifolius L.) — W SIBERIA: Alt. (Altai Territory: Zmeinogorsk District); E SIBERIA: Dau. (Buryat-Mongol ASSR: Kyakhta).

On Senecio taraxacifolius DC — CAUCASUS: E Transc. (Georgian SSR: Bakuriani).

On Senecio paluster (L.) Hook. — EUROPEAN PART: V.-Don. (Tula (according to Trusova)); W SIBERIA: Ob (Tobol'sk).

On Senecio viscosus L. — EUROPEAN PART: Balt. (Latvian SSR).

The biology of the fungus was studied in cultures by Wolff, Fischer, Klebahn, and other mycologists. The fungus can overwinter in the urediospore stage. Pathogenicity — see C. tussilaginis.

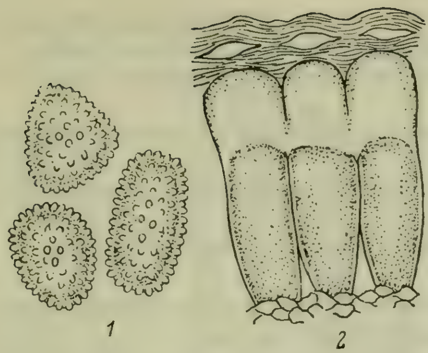


FIGURE 116. Coleosporium senecionis (Schum.) Fries on Senecio sp.:

1 — urediospores; 2 — teliospores; × 600. (Orig.)

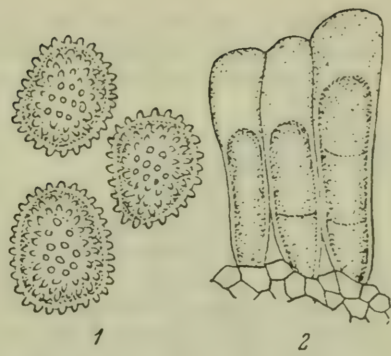


FIGURE 117. Coleosporium cacaliae (DC) Otth. on Cacalia hastata L.:

1 — urediospores; 2 — teliospores; × 600. (Orig.)

322 29. **Coleosporium cacaliae** (DC) Otth, Mitt. Naturf. Ges. Bern, (1865) 1866, S. 179; Syd., Monogr. Ured. III, 1915, p. 601; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 379.

Syn.: **Uredo cacaliae** DC, Encycl., 1808, p. 223.

Uredo cacaliae Rabenh., Kryptog.-Flora, ed. I, 1844, S. 12.

Coleosporium cacaliae Fuckel, Symb. mycol., 1869, p. 43; Grove, Brit. Rust Fungi, 1913, p. 325; Sacc., Sylloge, XXI, 1912, p. 721.

Coleosporium cacaliae Wagn., Ztschr. Pflanzenkr. VI, 1896; S. 11; Bubák, Rostpilze Böhmens, 1908, S. 148; Hariot, Uréd., 1908, p. 271; Migula, Kryptog.-Fl. Deutschl. III, 1, 1910, S. 462; Klebahn, Kryptogfl. M. Brandb. Va, 1914, S. 744; Fragoso, Fl. Iber. Ured. II, 1925, p. 321.

Peridermium magnusianum Fisch., Bull. Soc. bot. France, XLI, 1894, p. CLXXI.

Peridermium magnusii Wagn., Ztschr. Pflanzenkr. VI, 1896, S. 11.

Biol. Fischer, l. c., 1894; Entwicklungsgesch. Untersuch. über Rostpilze, 1898, S. 104; Wagner, l. c., 1896, p. 11.

Aecia, see **Coleosporium senecionis** (Schum.) Fries.

Uredia hypophyllous, scattered or gregarious, small, round, 0.4 — 0.7 mm in diameter, orange-colored. Urediospores ellipsoid, 25 — 40 × 18 — 25 μ; walls colorless, thin, 1.5 μ thick, verruculose.

Telia hypophyllous, scattered or in groups, round, 0.5 — 1.0 mm across, frequently coalescing in crusts, red. Teliospores prismatic, up to 140 μ long, 18 — 25 μ thick, rounded at the apex and thickened up to 30 μ (Figure 117).

Aecia on **Pinus** (**P. montana** Mill., **P. pumila** Rel.); uredio- and teliospores on **Cacalia** and **Adenostyles**.

General distribution: Europe, Asia (Siberia, Far East).

On **Pinus pumila** Rgl. — FAR EAST: Sakhalin (according to Hiratsuka).

On **Cacalia hastata** L. (=**Senecio sagittatus** Schultz Bip.) — EUROPEAN PART: Dv.-Pech. (Arkhangel'sk Region: Kholmogory), V.-Kama (Kirov Region: Omutninsk; Molotov, Krasnoufimsk), Transv. (Bashkir ASSR:

Belebei); W SIBERIA: Ob (Tobol'sk, Tomsk, Narym, Novosibirsk, Eniseisk, Krasnoyarsk), Irt. and Alt. (Altai); E SIBERIA: Lena-Kol. (Yakut ASSR: [former] Vitim-Olekma Subregion), Dau. (Buryat-Mongol ASSR); FAR EAST: Kamch.

On Cacalia hastata L. var. glabra Ldb. — FAR EAST: Sakhalin (according to Hiratsuka).

On Cacalia hastata L. var. pubescens Ldb. — FAR EAST: Sakhalin (according to Hiratsuka).

On Cacalia auriculata DC — FAR EAST: Uss. (Maritime Territory: Maikhe R.), Kamch.

On Cacalia auriculata DC var. ochotensis Maxim. et var. kamtschatica
323 Koidr. — FAR EAST: Sakhalin (according to Hiratsuka).

Connection of the fungus on Adenostyles alpina Bl. Fing. with the aecia on Pinus montana experimentally established. The fungus on species of Cacalia connected with P. pumila Rgl. and P. silvestris L. (?) apparently represents a particularly specialized race. Tranzschel (1939, p. 379) maintains that this species is identical with one of the C. senecionis races.

30. Coleosporium ligulariae Thüm., Bull. Soc. imp. nat. Moscou, LII, 1877, p. 140; Sacc., Sylloge, VII, 1888, p. 759; Liro, Ured. Fenn., 1908, p. 482; Syd., Monogr. Ured. III, 1915, p. 612; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 379.

Syn.: Coleosporium safianoffianum Thüm., Mycoth. univers. No. 1532, 1880 et Bull. Soc. imp. nat. Moscou, LV, 1880, p. 85; Sacc., Sylloge, VII, 1888; p. 758; Syd., Monogr. Ured. III, 1915, p. 599.

Aecia unknown.

Uredia hypophyllous, scattered or in groups, up to 2 cm wide, small, round, 0.5 mm in diameter, orange-colored. Urediospores globoid to prismatic, $21-36 \times 16-26\,\mu$; walls colorless, densely verrucose, $1.5-2.0\,\mu$ thick.

Telia hypophyllous, round, 0.5 — 1.0 mm in diameter, orange-colored. Teliospores cylindrical, $70-110 \times 19-28\,\mu$, strongly thickened at apex, $25-40\,\mu$ (Figure 118).

On species of Ligularia in northern Europe, Siberia, and the Far East.

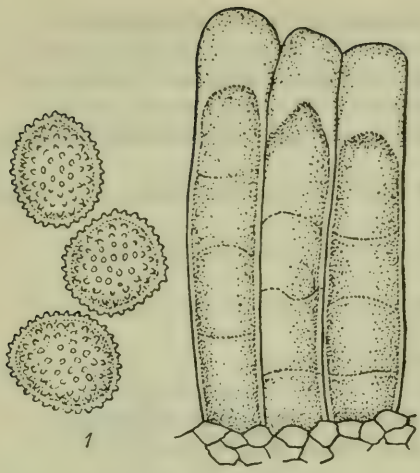
According to Tranzschel (1939) the original specimens of Coleosporium safianoffianum Thüm. appeared on Ligularia altaica DC (=L. glauca Hoffm.), not on Aronicum altaicum DC (=Doronicum altaicum Pall.) as indicated by Thümen.

On Ligularia glauca (L.) O. Hoffm. (=Senecillis glauca Ldb., incl. L. altaica DC) — W SIBERIA: Ob (Tomsk), Irt. and Alt. (Altai); E SIBERIA: Ang.-Say. (Minusinsk).

On Ligularia sibirica (L.) Cass. — EUROPEAN PART: Kar.-Lap. (Karelian ASSR), Dv.-Pech. (Arkhangel'sk Region: Kargopol'; Komi ASSR: Timan Mts.), Lad.-Ilm. (Leningrad Region: (Levashovo), Urals (Sverdlovsk Region: Taraskovo station); CAUCASUS: E Transc. (Georgian SSR: Borzhomi); W SIBERIA: Ob (Omsk Region: Manya R., Tobol'sk); E SIBERIA: Lena-Kol. (Kirensk), Ang.-Say. (Minusinsk, Sayan Mts., Irkutsk, Verkholensk), Dau. (Nerchinsk); FAR EAST: Uss. (Maritime Territory: Vladimiro-Alexandrovsk on the Suchan River), Sakh. (Kuril Is.).

On Ligularia speciosa F. et M. — FAR EAST: Dau. (Nerchinsk), Ze.-Bu.
324 (Blagoveshchensk), Uss. (Maritime Territory), Sakh. (Sakhalin, Kuril Is.).

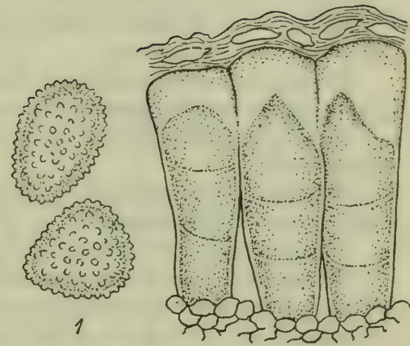
On Ligularia calthaefolia Max. — FAR EAST: Sakh. (Sakhalin, Kuril Is.).



1   2

FIGURE 118. Coleosporium ligulariae Thüm. on Ligularia glauca (L.) O. Hoffm.:

1 — urediospores; 2 — teliospores; × 600. (Orig.)



1   2

FIGURE 119. Coleosporium saussureae Thüm. on Saussurea japonica DC:

1 — urediospores; 2 — teliospores; × 600. (Orig.)

31. **Coleosporium saussureae** Thüm., Bull. Soc. imp. nat. Moscou, LV, 1880, p. 212; Sacc., Sylloge, VII, 1888, p. 757; Syd., Monogr. Ured. III, 1915, p. 614; Hirats., Trans. Sapporo Nat. Hist. Soc. IX, 2, 1927, p. 222; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 379.

Syn.: **Coleosporium saussureae** Diet., Engler's Bot. Jahrb. XXXIV, 1905, S. 588; Sacc., Sylloge, XXI, 1912, p. 719.

Biol. Hiratsuka, l. c., 1927.

Spermagonia subepidermal, 0.7 — 1.2 mm long, 0.3 — 0.5 mm wide, 98 — 140 μ high.

Aecia mostly hypophyllous, 0.5 — 1.6 mm long, 0.3 — 0.6 mm high.

Aeciospores globoid to prismatic, 23.4 — 34.2 × 18.0 — 23.4 μ; walls verruculose, about 2 μ thick.

Uredia hypophyllous, small, 0.25 — 0.6 mm across, scattered or in groups, orange-yellow. Urediospores varying in shape, usually ellipsoid or ovoid, 21.6 — 27.0 × 12 — 18 μ; wall densely verrucose, colorless, rather thin; contents yellow.

Telia hypophyllous, small, round, scattered or in groups, yellowish-orange. Teliospores cylindrical, 60 — 115 × 15 — 23 μ, at the apex thickened up to 18 — 25 μ; contents light-orange to yellow (according to Hiratsuka) (Figure 119).

Aecia on **Pinus pumila** Rgl. (and apparently on other species of **Pinus**); uredio- and teliospores on species of **Saussurea**.

General distribution: Asia.

Saussurea japonica DC. — FAR EAST: Uss. (Maritime Territory).

Saussurea tilesii Ldb. — FAR EAST: Kamch.

Saussurea maximowiczii Herder — FAR EAST: Uss. (Maritime Territory: Voroshilov).

Saussurea elongata DC — FAR EAST: Uss. (Maritime Territory: Grigor'evskoe village).

Saussurea grandifolia Max. — FAR EAST: Uss. (Maritime Territory: Okeanskaya station).

Saussurea latifolia Ldb. — W Siberia: Irt. and Alt. (Altai); E SIBERIA: Ang.-Say. (Sayan Mts.).

Saussurea subtriangulata Kom. — FAR EAST: Uss. (Maritime Territory: Lyanchikhe and Maikhe river basins).

Saussurea manchurica Kom. — FAR EAST: Sakhalin (according to Hiratsuka).

Saussurea nupuripoensis Miyabe et Miyake — FAR EAST: Sakhalin
325 (according to Hiratsuka).

Saussurea acuminata Turcz. — FAR EAST: Sakhalin.

Saussurea sachalinensis Fr. Schm. — FAR EAST: Sakhalin.

Hiratsuka (1927) obtained in cultures abundant uredia on **Saussurea riederi** Herd. upon sowing aeciospores from **Pinus pumila** Rgl.

32. Coleosporium synuri Tranz., Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 379, 370 (without diagnosis).

Aecia unknown.

Uredia hypophyllous, usually gregarious, orange-yellow, eliciting yellowish patches on the upper side of leaves. Urediospores globoid or ovoid, $16-27 \times 13.5-19\mu$; walls colorless, densely and rather coarsely verrucose (Figure 120).

Teliospores absent.

On **Synurus** in the Far East.

On **Synurus atriplicifolius** (Trev.) Iljin (= **Serratula atriplicifolia** Benth. et Hook.) — FAR EAST: Uss. (Maritime Territory: Okeanskaya station).

33. Coleosporium cirsii-japonici Diet., Ann. mycol. XII, 1914, p. 85; Syd., Monogr. Ured. III, 1915, p. 603; Sacc., Sylloge, XXIII, 1925, p. 855; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 380.

Telia hypophyllous in circular or irregular groups producing reddish patches, rounded, 0.3—0.5 mm in diameter, orange-colored, later pale yellow. Teliospores cylindrical or clavate, $60-100 \times 18-82\mu$, rounded at apex and thickened up to $14-30\mu$.

Only teliospores known, on leaves of **Circium japonicum** DC var. **vulcani** Fr. et Lav. from Japan. Might be found in the Soviet Far East on **Cirsium maackii** or **C. schantarense**.

34. Coleosporium aposeridis Syd., Monogr. Ured. III, 1915, p. 599; Fragoso, Fl. Iber. Ured. II, 1925, p. 322; Sacc., Sylloge, XXIII, 1925, p. 855; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 380.

Aecia unknown.

Uredia hypophyllous, producing reddish patches; in groups, small, 0.2 —0.4 mm in diameter, orange-colored, later fading. Urediospores angular-globoid or ellipsoid, densely verrucose, $18-25 \times 16-21\mu$; walls colorless, 1.5μ thick.

Telia hypophyllous, scattered or in groups, small, 0.2 — 0.4 mm across, orange-colored, later pale yellow. Teliospores cylindrical-clavate, 60 — 80 × 15 — 18 μ, at apex rounded and thickened up to 15 — 25 μ.

On **Aposeris foetida** in Europe: USSR, western Europe.

On **Aposeris foetida** Less. — EUROPEAN PART: U. Dns. (Lvov Region).

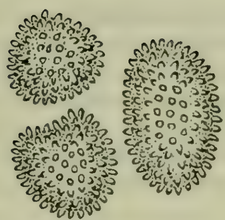


FIGURE 120. Coleosporium synuri Tranz. on **Synurus atriplicifolius** (Trev.) Iljin. Urediospores, × 600. (Orig.)

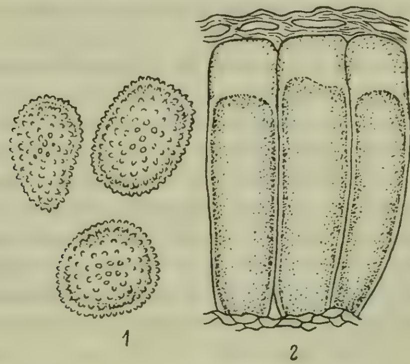


FIGURE 121. **Coleosporium sonchi-arvensis** (Pers.) Winter on **Sonchus arvensis** L.:

1 — urediospores; 2 — teliospores; × 600. (Orig.).

35. **Coleosporium sonchi-arvensis** (Pers.) Winter, Pilze, Deutschl. 1881, S. 247, pr. p.; emend. Fischer, Bull. Soc. bot. France, XLI, 1894, p. CLXIX; Liro, Ured. Fenn., 1908, p. 484; Trotter, Fl. Crypt. Ital.
326 Ured., 1914, p. 373; Sacc., Sylloge, XXI, 1912, p. 722; Arth., N. Amer. Fl. VII, 1925, p. 660; Manual Rusts U. S. a. Canada, 1934, p. 49, fig. 72; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 380.

Syn.: **Coleosporium sonchi** (Schum.) Lév., Ann. sci. natur. III, sér. VIII, 1847, p. 373; Sacc., Sylloge, VII, 1888, p. 752; Fischer, Ured. Schweiz, 1904, S. 453; Bubák, Rostpilze Böhmens, 1908, S. 180; Hariot, Uréd., 1908, p. 275; Migula, Kryptog.-Fl. Deutschl. III, 1, 1910, S. 464; Grove, Brit. Rust Fungi, 1913, p. 324, fig. 244; Klebahn, Kryptogfl. M. Brandb. Va, 1914, S. 750, Fig. M 10 (S. 746); Syd., Monogr. Ured. III, 1915, p. 621; Fragoso, Fl. Iber. Ured. II, 1925, p. 332, fig. 156.

Uredo sonchi-arvensis Pers., Syn. fung., 1801, p. 217.

Uredo sonchi Schum., Pl. Saell. II, 1803, p. 229.

Uredo sonchi Martius, Prodr. fl. Mosqu., ed. II, 1817, p. 230.

Peridermium Fischeri Kleb., Ztschr., Pflanzenkr. V, 1895, S. 71.

Biol. Fischer, l. c., 1894; Entwicklungsgesch. Untersuch. über Rostpilze, 1898, S. 102; Klebahn, Ztschr. Pflanzenkr. V, 1895, S. 69; XXIV, 1914, S. 18; Wirtswechs. Rostpilze, 1904, S. 361; Wagner, Ztschr. Pflanzenkr. VIII, 1898, S. 345; Vanin, Lesn. fitopatol., 1948, p. 112.

Spermagonia usually epiphyllous, 0.5 — 1.0 mm long, 0.2 — 0.3 mm wide.

Aecia amphigenous, 1 — 2 mm long, 0.5 — 1.0 mm high. Aeciospores angular-globoid, ovoid, or ellipsoid, $22-25 \times 16-25\,\mu$; walls colorless, densely verrucose, $2-3\,\mu$ thick.

Uredia hypophyllous, about 0.5 mm in diameter, orange-colored. Urediospores globoid, ovoid, or slightly irregular in shape, $18-27 \times 14-20\,\mu$; walls colorless, $1.0-1.5\,\mu$ thick, densely verruculose.

Telia small, often in large groups, red. Teliospores, cylindrical, up to $100\,\mu$ long, $18-24\,\mu$ thick; walls colorless, at apex thickened up to $15-20\,\mu$ (Figure 121).

Aecia on needles of **Pinus silvestris** L.; uredio- and teliospores on species of **Sonchus**.

General distribution: Europe, Asia (West Siberia).

On **Sonchus arvensis** L. — EUROPEAN PART: Kar.-Lap. (Karelian ASSR), Dv.-Pech. (Arkhangel'sk Region, Kargopol', Vel'sk), Lad.-Ilm. (Leningrad Region), Balt. (Latvian SSR, Estonian SSR, Lithuanian SSR), U. V. (Moscow and Ivanovo regions), V.-Kama (Gorki and Kirov regions, Tatar ASSR), U. Dns. (Lvov Region), M. Dnp. (Belaya Tserkov, Vinnitsa), V.-Don. (Voronezh and Kuibyshev regions), Urals (Sverdlovsk Region); CAUCASUS: Cisc. (Ordzhonikidze Territory: Voroshilovsk); W SIBERIA: Ob (Sverdlovsk and Omsk regions).

On **Sonchus asper** Hill. — EUROPEAN PART: Lad.-Ilm. (Leningrad
327 Region), Balt. (Lithuanian SSR), U. V. (Moscow Region), U. Dns. (Lvov, Ternopol', and Drogobych regions), M. Dnp. (Uman).

On **Sonchus oleraceus** L. — EUROPEAN PART: Kar.-Lap. (Karelian ASSR), Balt. (Estonian SSR) Lad.-Ilm. (Leningrad Region), U. V. (Moscow and Ivanovo regions), V.-Kama (Gorkii Region, Tatar ASSR), U. Dnp. (Smolensk and Orel regions), M. Dnp. (Ukrainian SSR), V.-Don (Kuibyshev Region), Urals (Sverdlovsk Region).

The heteroecism of this fungus was established by Fischer (1894) by sowing in fall germinating teliospores from **Sonchus asper** on needles of **Pinus silvestris**. Back-sowing of aeciospores (from **Pinus silvestris**) proved infective for **Sonchus oleraceus** L., but not for **Senecio silvaticus**, **Inula uaillantii**, **Adenostyles alpina**, **Tussilago farfara**, **Campanula trachelium**. According to Klebahn (1914) the fungus that infects **Sonchus arvensis** does not pass onto **Schizanthus grahami** Gill. and **Tropaeolum minus** L. The pathogenicity of the aecial stage, which causes yellowing of pine needles, was not sufficiently studied (see **Coleosporium tussilaginis**).

SUPPLEMENT TO SPECIES OF COLEOSPORIUM

Coleosporium vagans (Dietr.) Tranz., Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 333.

Under this designation we unite **Coleosporium** forms of different species passing onto chance hosts. Thus, in Klebahn's experiments several species of **Coleosporium** (**C. campanulae**, **C. euphrasiae**, **C. melampyri**, **C. tussilaginus**) developed on **Schizanthus grahami**; in the same experiments **Tropaeolum minus** proved susceptible to **Coleosporium tussilaginis**, **C. senecionis**, and

C. campanulae. To the forms observed on chance hosts is referred Coleosporium tropaeolum Palm. (in Vestergr. Microm. Sel. No. 1456), and Uredo vagans Dietr ch (Arch. Naturk. Liv.-, Ehst- u. Kurlands, II Ser., I, 1859, S. 429). Diet ch indicated the development of the fungi in many garden plants — Schizanthus grahami, Tropaeolum canariense, etc.; among Dietrich's exsiccatae (Crypt. Cent. VIII, 12, and also of the fungi on Tropaeolum aduncum, 9/53, Ehstland) are specimens of Coleosporium.

Apparently, to this form should be referred Coleosporium cerinthes Schroeter (Kryptog.-Fl. Schles., III, 1, Hälfte, 1887, S. 370; Migula, Kryptg.-Fl. Deutschl., III, 1, 1910, S. 466; Saccardo, Sylloge, VII, 1888, p. 755; Sydow, Monogr. Ured., III, 1915, p. 643), found once in Silesia in the uredio- and teliospores stages. Voronin found urediospores of Coleosporium on Helianthus annuus (Tr. St. Peterb. obshch. estestvoispyt., II, 1871, p. 171); according to Tranzschel (1939, p. 333) this find can hardly be referred to the North American species Coleosporium helianthi (Schw.) Arthur (Manual of the Rusts of the United States and Canada, 1934, p. 47). Here belongs the Coleosporium collected by Tranzschel (l. c.) on Nicotiana affinis Moore near Leningrad, and Uredo nicotianae Anast. (Sacc. et Splend. in Saccardo, Sylloge, XVII, 1905, p. 400; Sydow, Monogr. Ured., IV, 1924, p. 415; Trotter, Fl. Ital. Crypt. Ured., 1914, p. 449) (Figure 122).

Coleosporium sp.

Aecia of Coleosporium are found in the USSR on the following species of genus Pinus.

Pinus silvestris L. — EUROPEAN PART: Kar.-Lap. (Karelian ASSR),
Lad.-Ilm. (Leningrad Region), Dv.-Pech. (Arkhangel'sk Region: Vel'sk,
Vologda Region: Kadnikov), Balt. (Lithuanian SSR, Latvian SSR), U. V.
(Moscow and Ivanovo regions), V.-Kama (Gorkii and Kirov regions), U. Dnp.
328 (Smolensk Region, Belorussian SSR), U. Dns. (Lvov Region, etc.), M. Dnp.
(Kursk Region), V.-Don (Voronezh and Kuibyshev regions), Urals
(Sverdlovsk Region): CAUCASUS: E Transc. (Georgian SSR: Bakuriani);
W SIBERIA: Irt. (Kokchetav Region); E SIBERIA.

FIGURE 122. Coleosporium vagans (Dietr.) Tranz.:

1 — urediospores on shoots of Helianthus annuus L.; 2 — teliospores on Schizanthus grahami Gill.; × 600. (Orig.)

Pinus montana Medw. — EUROPEAN PART: Balt. (Lithuanian SSR: Kaunas (Botanical Garden)).

Coleosporium papaveris Tranz. (n. nud.) Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 202, 203. Sole herbarium specimen (type!) on Papaver nudicaule L. s. l., devoid of spores.

16. Genus OCHROPSORA Diet.

Diet., Ber. Deutsch. bot. Ges. XIII, 1895, S. 401; Tranzschel, Tr. Bot. Muz. Akad. Nauk, II, 1904, p. 17—23; Syd., Monogr. Ured. III, 1915, p. 660.

Spermagonia conical, flat at the base, subcuticular, whitish. Aecia with cupular peridia. Uredia bordered by paraphyses growing at the base like peridia; urediospores single, verrucose (or echinulate); germ pores inconspicuous. Telia pale, waxy; teliospores cylindrical, fused in flat crusts, dividing when mature into 4 cells (basidia), each one forming a prismatic basidiospore.

Three species are known. Of these, one species widespread in Europe is infiltrating in the Far East; the other two species, described in Japan, are doubtful.

On Rosaceae

1. Ochropsora ariae (Fuckel) Syd., Monogr. Ured. III, 1915, p. 661, tab. XXXI, fig. 189 (p. 659); Fragoso, Fl. Iber. Ured. II, 1925, p. 336, fig. 157,
329 158, Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 225.

Syn.: Aecidium leucospermum DC, Fl. franç., II, 1805; VI, 1815, p. 90.

Melampsora ariae Fuckel, Symb. mycol., 1869, p. 45; Sacc., Sylloge, VII, 1888, p. 592.

Melampsora sorbi Wint., Pilze Deutschl., 1881, S. 241.

Uredo arunci Schroet. in 56. Jahresber. Schles. Ges. vaterl. Cult., 1878, S. 128.

Caeoma sorbi Oud., Nederl. Kruidk. Arch., 2 ser., I, 1872, p. 177; Arch. Neerland. VIII, 1873, p. 383.

Ochropsora sorbi (Oud.) Diet., Ber. Deutsch. bot. Ges. XIII, 1895, S. 401; Fischer, Ured. Schweiz, 1904, S. 455, Fig. 301; Hariot, Uréd., 1908, p. 277, fig. 41; Liro, Ured. Fenn., 1908, p. 436; Migula, Kryptog.-Fl. Deutschl. III, 1, 1910, S. 461, Taf. X, Fig. 1; Grove, Brit. Rust Fungi, 1913, p. 329, fig. 248, 249; Klebahn, Kryptogfl. M. Brandb. Va, 1914, S. 754, 901, Fig. 1 (S. 746); Trotter, Fl. Ital. Crypt. Ured., 1914, p. 378, fig. 95.

Ochropsora pallida Lind, Danisch fungi, 1913, p. 95.

Biol. Tranzschel, Tr. Bot. Muz. Akad. Nauk, II, 1904, p. 17—23; Centrbl. Bakteriol. II. Abt., XI, 1903, S. 106; Klebahn, Wirtswechs. Rostpilze, 1904, S. 356; Ztschr. Pflanzenkr. XV, 1905, S. 80; XVII, 1907, S. 143; Fischer, Ured. Schweiz, 1904, S. 455; Ber. Schweiz. bot. Ges. XV, 1905; Centrbl. Bakteriol. II, Abt., XXVIII, 1910, S. 149.

Spermagonia epiphyllous, between the cuticle and epidermis, whitish, conical, flattened at base, 120 — 135 μ across, covered by a brownish membrane, the paraphyses, projecting above it.

Aecia on systemic mycelium, 0.4 mm across; peridia cupular, with outwardly flexed fimbriate margins, white; peridial cells almost rectangular, overlapping by the downward projecting wedge-shaped processes; cell walls thick; outer wall cross-striated, 6 — 9 μ thick, outer wall 3 — 5 μ thick, furrowed in structure, coarsely verrucose. Aeciospores blunt-angular, 16 — 30 × 18 — 21 μ; walls evenly thick, about 1 μ, rarely slightly thicker on one side, verruculose; distance between warts less than 1 μ; contents colorless.

Uredia round, scattered over the entire underside of leaves on whitish-yellowish patches, white, up to 0.25 mm across, surrounded by a crown of paraphyses, growing together at the base like peridia. Urediospores globoid, ellipsoid, or ovoid, 22 — 28 × 15 — 25 μ; walls colorless or pale rust-brown, 1.0 — 1.5 μ thick, verrucose; distance between verrucules about 1.5 μ; pores inconspicuous.

Telia hypophyllous, covered by the epidermis, later exposed, whitish, 0.25 — 0.5 mm across, in small groups. Teliospores 30 — 60 × 8 — 10 μ, thickly set, like a palisade, cylindrical, rounded at apex, single, later

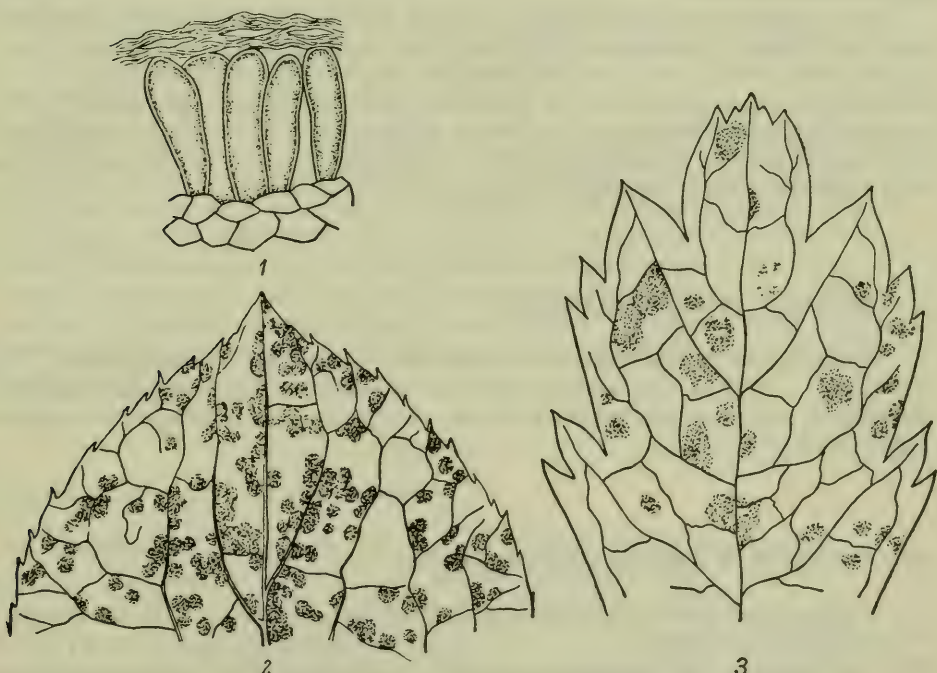


FIGURE 123. Ochropsora ariae (Fuckel) Syd.:

1 — teliospores on **Pirus communis** L., × 525; 2 — aecia on **Anemone nemorosa** L., × 525; 3 — telia on **Sorbus aucuparia** L., × 4.2. (Orig.)

divided by transverse septa into 4 cells (basidia), germinating as soon as mature; contents colorless, grayish.

Basidiospores are formed one to each cell of the basidia, elongated-ovoid,
330 $22-26 \times 8-10 \mu$ with thin, colorless walls (Figure 123).

Aecia on species of Anemone; uredio- and teliospores on species of Sorbus, Pirus, and Aruncus.

General distribution: Europe, Asia (Far East).

On Anemone nemorosa L. — EUROPEAN PART: Kar.-Lap. (Karelian ASSR (according to Liro)), Lad.-Ilm. (Leningrad Region), Balt. (Estonian SSR), U. Dns. (Lvov Region).

On Anemone ranunculoides L. — EUROPEAN PART: Balt. (Estonian SSR), V.-Don (Tambov Region, Kursk Region: Borisov District), L. Don (Rostov Region).

On Anemone glabrata (Max.) Juz. (=Anemone baicalensis Turcz. var. glabrata Maxim.) — FAR EAST: Uss. (Maritime Territory: Voroshilov, Grigor'evskoe village).

On Sorbus aucuparia L. s. l. — EUROPEAN PART: Lad.-Ilm. (Leningrad Region), U. Dnp. (Vitebsk), U. Dns. (Ternopol' Region).

On Pirus communis L. — EUROPEAN PART: V.-Don (Kursk Region), U. Dns. (Lvov Region); CAUCASUS: Cisc. (Ordzhonikidze Territory: Beshtau; Krasnodar Territory: Tuapse).

On Aruncus silvester Kost. — FAR EAST: Uss. (Maritime Territory: Okeanskaya station).

The connection of Ochropsora ariae on Sorbus aucuparia with Aecidium leucospermum on Anemone nemorosa was experimentally established by Tranzschel (1903, 1904). Later, Klebahn and Fischer succeeded in
331 transferring aeciospores from Anemone onto Sorbus aria, S. fennica, S. intermedia, S. americana, and Pirus communis. Tranzschel considered the fungal form on Aruncus silvester a biological race of Ochropsora ariae, an assumption experimentally substantiated by Fischer.

V. Subfamily MELAMPSOREAE

Aecia devoid of peridia and paraphyses, caeomoid. Urediospores produced. Teliospores subcuticular or subepidermal, unicellular, rarely bicellular, solitary, jointed in the form of a palisade in a single- or many-layered crust.

Key to Genera of Subfamily Melampsoreae

I. Teliospores brown or yellowish-brown, overwintering. In the uredia capitate paraphyses . . . . 17. Melampsora Cast. (p. 431)

II. Teliospores pale, almost colorless, germinating soon after maturation.
   - A. Urediospores unknown . . . . 18. Chnoopsora Diet. (p. 494)
   - B. Urediospores present . . . . 19. Aplospora Mains. (p. 496)

17. Genus MELAMPSORA Cast.

Cast., Observ. mycol. II, 1843, p. 18; Klebahn, Kryptogfl. M. Brandb. Va, 1914, S. 758; Syd., Monogr. Ured. III, 1915, p. 334.

Syn.: **Physoderma** Lév., Ann. sci. natur. III, sér. VIII, 1847, p. 374.

Podocystis Fries, Summa Veget. Scand. II, 1849, p. 512.

Necium Arth., N. Amer. Fl. VII, 1907, p. 114.

Spermagonia flat, hemispherical or truncate-conoidal, subepidermal, or between the cuticle and epidermis.

Aecia flat, usually slightly projecting in the form of round cushions, without peridia, caeomoid, orange-yellow. Aeciospores in chains; walls colorless with a sparsely verrucose or striated structure.

Uredia usually hypophyllous, projecting from under the epidermis, with very rudimentary evanescent peridia, if at all, orange-tinted. Urediospores solitary, globoid or prismatic with capitate, colorless paraphyses; walls colorless, verrucose or echinulate, occasionally smooth at apex.

Telia usually hypophyllous, in a single- or many-layered crust, occasionally coalescent in large angular patches, compact, covered for a prolonged period of time by the epidermis or cuticle, brown or black. Teliospores unicellular, rarely divided by a transverse septum into 2 cells, prismatic, fused in a kind of palisade, in tight groups; walls brown, thin, in some species thickened at the apex, smooth. Teliospores over-wintering.

Basidiospores globoid, colorless or pale yellow.

From time to time a few round teliospores are not free as soon as produced, resembling teliospores of **Uromyces** species (dual or paired
332 teliospores: see **Melampsora vernalis** Niessl.).

More than 80 species are known on different plants, mainly in the northern hemisphere. In the USSR there are 35 species, 26 of which are heteroecious on Salicaceae, one with aecia on conifers, the others on **Orchidaceae**, as well as on species of **Allium, Chelidonium, Corydalis**, Saxifraga, Ribes, Mercurialis; one species is monoecious with the entire cycle of development on Salix **amygdalina** or S. pentandra. All other species are probably monoecious on different **Compositae**; on **Euphorbiaceae**, 6 species; on **Guttiferae**, 2 species; on Linaceae, 2 species; etc. Some species are widely distributed, severely damaging agriculture and the forest economy.

Key to Species of Genus Melampsora

I. Uredio- and teliospores on species of Salix, family Salicaceae.
- A. Teliospore wall more or less thickened at apex.
  - 1. Wall strongly thickened at apex, up to $6-10\mu$.
    - a. On **Salix berberifolia** Pall. . . . . . 1. M. berberifolii Kupr.
    - b. On other species of **Salix** . . . . 2. M. larici-caprearum Kleb.

2. Wall slightly thickened at apex, to 1.5—2.0 μ.
   a. Urediospores globoid, broad-ellipsoid.
      + Uredia and telia hypophyllous on leaves of section Capreae . . . . 3. M. evonymi-caprearum Kleb.
      ++ Uredia and telia amphigenous on leaves of sections Hebraceae and Arcticae . . . . 4. M. arctica Rostr.
   b. Urediospores ellipsoid, rarely prismatic or globoid.
      + On Salix reticulata L. . . . . . . 5. M. reticulatae Blytt.
      ++ On Salix jessoensis Seem. . . . . 6. M. jezoensis Miyabe et Mats.

B. Teliospore wall without thickenings at apex.
1. Urediospores globoid, broad-ellipsoid.
   a. Urediospore wall uniformly thick, to 2 μ.
      + Wall verruculose, urediospore 13—15 μ in diameter . . . . 7. M. abieti-caprearum Tub.
      ++ Wall moderately verrucose, urediospores 13—17 × 12—14 μ . . . 8. M. orchidi-repentis (Plowr.) Kleb.
      +++ Wall coarsely verrucose, urediospores 15—24 × 14—20 μ. . . . . 9. M. ribesii-viminalis Kleb.
   b. Wall up to 3—4 μ thick.
      + Wall unevenly thickened, 3.0—3.5 μ . . . . 10. M. ribesii-epitea Kleb.
      ++ Wall evenly thickened, 1—4 μ, paraphyses mainly bordering uredia . . . . 11. M. lapponum Lindfors.
      +++ Wall 2.6—3.5 μ thick, paraphyses scattered . . . . 11a. M. bigelowii Thüm. (in N. America)
2. Urediospores ellipsoid, ovoid, slightly elongate, rarely globoid.
   a. Wall sparsely and coarsely verrucose on Salix pierotii Miq. . . . . 12. M. chelidonii-pierotii Mats.
   b. Wall rarely verrucose, on other species of Salix . . . . 13. M. larici-epitea Kleb.
3. Urediospores digitate, prismatic, rarely ellipsoid. Monoecious
333 species.
   a. Wall about 2 μ thick.
      + Telia hypophyllous on Salix pentandra L. . . . . 14. M. larici-pentandrae Kleb.
      ++ Telia mainly epiphyllous, uredia on leaves and bark; on Salix alba L. . . . 15. M. allii-salicis albae Kleb.
   b. Wall about 3 μ thick, on Salix fragilis L. and S. pentandra L. . . . . 16. M. allii-fragilis Kleb. (aecia on Allium).
      17. M. galanthi-fragilis Kleb. (aecia on Galanthus).
4. Monoecious species, 0, I, II, III on Salix amygdalina L. . . . . 18. M. amygdalinae Kleb.

II. Uredio- and teliospores on species of Populus.
A. Urediospores globoid, broad-ellipsoid, ovoid.
1. Wall almost smooth, faintly verrucose; telia amphigenous, mostly hypophyllous . . . . 19. M. microspora Tranz. et Eremeeva.

2. Wall rarely verrucose, telia hypophyllous ... 20. M. rostrupii Wagn.

3. Wall coarsely verrucose, telia amphigenous ... 21. M. pruinosae Tranz.

B. Urediospores ellipsoid, rarely globoid or prismatic.

1. Wall evenly thickened.

a. Urediospores $17-26 \times 13-24\,\mu$, wall to $3\,\mu$ thick ... 22. M. magnusiana Wagn.

b. Urediospores $15-22 \times 10-15\,\mu$, wall about $2\,\mu$ thick ... 23. M. larici-tremulae Kleb.

2. Urediospore wall with thickenings at both ends and thickened spots ... 24. M. pinitorqua (A. Br.) Rostr.

C. Urediospores digitate or prismatic.

1. Wall with equatorial thickenings, telia epiphyllous ... 25. M. larici-populina Kleb.

2. Wall without equatorial thickenings, telia mainly hypophyllous ... 26. M. allii-populina Kleb.

III. Uredio- and teliospores on species of Saxifraga, family Saxifragaceae.

A. Produce aecia; teliospores in large sori, $24-50 \times 9-14\,\mu$, in small sori, $17-30 \times 17-25\,\mu$. Species monoecious ... 27. M. vernalis Niessl.

B. Aecia absent; teliospores $30-52 \times 10-16\,\mu$ ... 28. M. hirculi Lindr.

IV. Uredio- and teliospores on species of Linum, family Linaceae.

A. Urediospores $13-18\,\mu$ across, teliospores $56-78$ $(84) \times 7-8$ $(10)\,\mu$; on cultivated flax and some other species ... 29. M. lini-usitatissimi (Pers. pr. p.) Kupr.

B. Urediospores $15-30\,\mu$ across, teliospores (39) $48-57$ (60) $\times$ $8-12\,\mu$; only on wild species of flax ... 30. M. lini-cathartici (Buchh.) Kupr.

V. Uredio- and teliospores on species of Euphorbiaceae.

A. On Ricinus, only urediospores known, $18-30 \times 16-22\,\mu$; wall

334 $2-3\,\mu$ thick ... 31. M. (?) ricini Pass.

B. On species of Euphorbia (and Andrachne).

1. Teliospores $18-30$ (up to 65) $\times$ $7-12$ (to 22) μ ... 32. M. euphorbiae (Schub.) Cast.

2. Teliospores $57.5-87.5 \times 7.5-12.5\,\mu$ ... 33. M. gelmii Bresadola.

VI. Uredio- and teliospores on species of Hypericum, family Guttiferae.

A. Only urediospores are known, $18-21 \times 14-16\,\mu$; wall about $2\,\mu$ thick; on Hypericum humifusum L. ... 34. Uredo (Melampsora ?) hyperici-humifusi Kleb.

B. Teliospores present.

1. Aecia known; teliospores, $20-30 \times 10-16\,\mu$ ... 35. M. hypericorum (DC) Schroet.

2. Aecia absent; teliospores $22-32 \times 6-12\,\mu$ ... 36. M. kusanoi Diet.

VII. Uredio- and teliospores on species of family Thymelaeaceae.

A. On Daphne ... 37. M. daphnicola (Diet.) Jørst.

B. On Stellera ... 38. M. stellerae Teich.

VIII. Uredio- and teliospores on Indian hemp (Apocynum, family Apocynaceae . . . . 39. M. apocyni Tranz.

On Salix (family Saliceae)

1. Melampsora berberifolii Kupr. sp. nov.

Spermagonia, aecia and uredia not recorded.

Telia epiphyllous on drying leaves, rarely hypophyllous, round, scattered over the entire frond, solitary, usually 0.2 — 0.5 mm wide, black-brown, between the cuticle and epidermis. Teliospores prismatic, wedge-shaped, ellipsoid rounded at both ends or apically flattened, frequently provided with a papilla, 28.5 — 50 × 8 — 16.5 μ; walls light brown, about 2 μ thick, but at the apex thickened up to 6 μ, brown. Pore conspicuous (Figure 124).

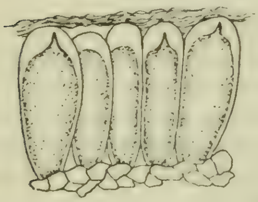


FIGURE 124. Melampsora berberifolii Kupr. on Salix berberifolia Pall. Teliospores, × 600. (Orig.)

The fungus resembles M. larici-caprearum Kleb., and is distinguished by somewhat less thickened apex of teliospore, and, frequently, by the presence of apical papilla.

On Salix berberifolia Pall. — E SIBERIA: Ang.-Say. (Irkut River basin, on bare peaks at the upper reaches of the Buyutui River, collected by V. I. Smirnov, 6 August, 1922); ARCTIC: An. (along Anadyr R.).

2. Melampsora larici-caprearum Kleb., Ztschr. Pflanzenkr. VII, 1897, S. 326, Fig. (S. 328); Fischer, Ured. Schweiz, 1904, S. 483, Fig. (S. 312); Sacc., Sylloge, XVII, 1905, p. 463; Bubák, Rostpilze Böhmens, 1908, S. 197; Hariot, Uréd., 1908, p. 260; Liro, Ured. Fenn., 1908, p. 541; Migula, Kryptog.-Fl. Deutschl. III, 1, 1910, S. 478; Grove, Brit. Rust Fungi, 1913, p. 338, fig. 254, 255; Trotter, Fl. Ital. Crypt. Ured., 1914, p. 412, fig. 105; Klebahn, Kryptogfl. M. Brandb. Va, 1914, S. 785, Fig. O 12 (p. 794); Syd., Monogr. Ured. III, 1915, p. 353, tab. XIV, fig. 141; Fragoso, Fl. Iber. Ured. II, 1925, p. 215; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 165.

Syn.: Caeoma laricis Hartig, Wichtige Krankh. d. Waldbaüme, 1874,
335 S. 93, pr. p.

Uredo larici-caprearum Arth., Résult. scient. Congr. intern. bot. Vienne 1905, 1906, p. 338.

Biol. Klebahn, Ztschr. Pflanzenkr. VII, 1897, S. 326; IX, 1899, S. 138; XII, 1902, S. 39; XV, 1905, S. 103; XVII, 1907, S. 155; Jahrb. wiss. Bot. XXXIV, 1900, S. 371; XXXV, 1901, S. 685; Wirtswechs. Rostpilze, 1904, S. 418; Jacky, Ber. Schweiz. bot. Ges. IX, 1899, S. 25; Schneider, Centrbl. Bacteriol. II. Abt., XVI, 1906, S. 161; Liro, Acta Soc. fauna et flora Fenn., XXIX, 6, 1906, p. 6; Dietel, Centrbl. Bacteriol. II. Abt., XXXI, 1911, S. 95; Hirats., Japan. Journ. Botany, VI, 1, 1932, p. 10.

Spermagonia subcuticular, 80 — 100 μ wide, about 20 μ high.

Aecia scattered and few on yellowish patches, to 1 mm high, pale orange-colored. Aeciospores globoid, ellipsoid, or angular, 15 — 25 × 12 — 17 μ; walls about 2 μ thick, covered by very short furrows or fine verrucules, 0.25 μ wide, at distances of approximately 1 μ.

FIGURE 125. Melampsora larici-caprearum Kleb. on Salix caprea L.:

1 — teliospores, × 525; 2 — leaf of S. caprea with telia, × 4.2. (Orig.)

Uredia hypophyllous, at first single and rather large, later small, scattered over entire frond, 1 — 2 mm, causing appearance of yellowish patches on the upper side of the leaf. Urediospores ovoid, globoid, or angular, 14 — 21 × 13 — 15 μ; walls 2.0 — 2.5 μ thick, sparingly verrucose (at intervals of 2.0 — 2.5 μ); a conspicuous thin spot on the wall probably indicates site of pore. Paraphyses 50 — 60 μ long, rounded, capitate, from 18 to 26 μ wide, and pedicels 5 — 6 μ thick, wall 5 μ thick.

336 Telia epiphyllous, between the cuticle and epidermis, first yellowish and later red-brown and dark brown; individual sori small, 1.0 — 1.5 mm, scattered over entire frond, frequently coalescing in crusts, occasionally covering the entire leaf surface. Teliospores prismatic, 30 — 45 × 7 — 14 μ; walls light brown, thin, about 1 μ, but thickened at the apex up to 10 μ, with a conspicuous, slightly excentric pore (Figure 125). Basidiospores orange-colored.

Heteroecious. Aecia on **Larix**; uredio- and teliospores on **Salix caprea** L., **S. caprea** × **viminalis**, rarer on **S. aurita** L. The fungus is easily distinguished by the extremely thickened apex of the teliospores.

General distribution: Europe, Asia.

On species of **Larix** (see **Caeoma laricis**).

On **Salix caprea** L. — EUROPEAN PART: Lad.-Ilm., U. V., V.-Kama, Urals, U. Dnp.; W SIBERIA: Ob (Krasnoyarsk); FAR EAST: Sakh. (S Sakhalin).

On Salix bakko Kimura — FAR EAST: Sakh. (S Sakhalin).

The connection of aecia on Larix with the fungus on Salix caprea was established by Klebahn (1897); the fungus was transmitted in cultures onto S. aurita, S. caprea × viminalis, and according to Schneider (1906) also onto Salix daphnoides, S. cinerea, S. nigricans, S. grandifolia; infection of the latter was weak. In natural conditions the fungus occurs on S. caprea and rarely on S. aurita.

3. **Melampsora evonymi-caprearum** Kleb., Jahrb. wiss. Bot. XXXIV, 1900, S. 358, Fig. (S. 362); Fischer, Ured. Schweiz, 1904, S. 489; Sacc., Sylloge, XVII, 1905, p. 463; Bubák, Rostpilze Böhmens, 1908, S. 199; Hariot, Ured., 1908, p. 262; Migula, Kryptog.-Fl. Deutschl. III, 1, 1910, S. 480; Grove, Brit. Rust Fungi, 1913, p. 339, fig. 256 (p. 340); Trotter, Fl. Ital. Crypt. Ured., 1914, p. 415; Klebahn, Kryptogfl. M. Brandb. Va, 1914, S. 800, Fig. O18 (S. 794); Syd., Monogr. Ured. III, 1915, p. 359, Fragoso, Fl. Iber. Ured. II, 1925, p. 200; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 158.

Syn.: Caeoma evonymi Schroet. (Saccardo, Sylloge, VII, 1888, p. 867).

Uredo evonymi Mart., Prodr. fl. Mosqu., 1812, p. 320.

Uredo evonymi-caprearum Arth., Résult. scient. Congr. intern. bot. Vienne 1905, 1906, p. 338.

Biol. Rostrup, Overs. Vid. Selsk. Forh. 1884, p. 13; Schneider, Centrbl. Bacteriol. II. Abt., XIII, 1904, S. 222; XVI, 1906, S. 89, 169; Klebahn, Jahrb. wiss. Bot. XXXIV, 1900, S. 358; XXXV, 1901, S. 686; Wirtswechs. Rostpilze, 1904, S. 425.

Spermagonia with slightly concave hymenium, 200 μ wide, 80 μ high.

Aecia hypophyllous, occasionally also epiphyllous on yellowish-orange patches, in rather large groups, up to 2 mm, bright orange-colored. Aeciospores usually ovoid, rarely globoid or ellipsoid, slightly angular, $18-23 \times 14-19\,\mu$; walls thick, up to 5 μ between the thinned sites, sparsely verrucose; verrucules $0.25-0.5\,\mu$ wide, at intervals of $0.71-1.0\,\mu$ (Figure 126).

Uredia hypophyllous, small, 0.5 mm, scattered over entire frond, single and in groups, causing appearance of yellow spots on the upper side of the leaf. Urediospores usually globoid, rarely ovoid, slightly angular,
337 $14-19 \times 14-17\,\mu$; walls unevenly thickened, 1.5 μ, in places up to 4 μ, sparsely verrucose (at 2 μ intervals), without smooth areas. Paraphyses $50-70\,\mu$ long, capitate, on thin pedicels; caps $18-25\,\mu$, pedicels $4-5\,\mu$ wide; wall, about 2 μ thick reaching up to 8 μ at the upper part of the caps.

Telia hypophyllous, subepidermal, small, about 0.5 mm, coalescing in groups covering leaf areas in between the foliar veins, brown with a gray-blue tint, eliciting brown patches on the upper side of the leaves. Teliospores irregularly prismatic rounded at both ends, $25-40 \times 7-13\,\mu$; walls thin, light brown, slightly thickened at the apex; pore inconspicuous.

Heteroecious. Aecia on Evonymus europaea L.; uredio- and teliospores on Salix aurita L., S. cinerea L., S. incana Schr. (? = S. caprea L.).

Forma sp. evonymi caprearum typica Kleb. (Kryptogfl. M. Brandb. Va, 1914, S. 800). On Salix aurita L. and S. cinerea L.; passed in cultures onto Salix caprea L.

Two biological forms of the fungus are known.

Forma sp. evonymi-incanae O. Schneider (Centrbl. Bacteriol. II, Abt., XIII, 1904, S. 222; XVI, 1906, S. 89, 169). On Salix incana Schrank; aeciospores rather thin-walled; paraphyses usually not thick-walled at apex.

General distribution: Europe (including the Caucasus).

On Evonymus europaeus L. — EUROPEAN PART: V.-Don., M. Dnp., Bl., Balt., U. Dns. (Stanislav Region); CAUCASUS: Dag.

On Evonymus verrucosa Scop. — EUROPEAN PART: U. V.; CAUCASUS: E Transc.

On Evonymus latifolia Scop. — CAUCASUS: E Transc.

On Salix cinerea L. — EUROPEAN PART: M. Dnp.

The aecial hosts have been established by experimental infections. Cultures of the fungus on S. aurita and S. cinerea infected also S. caprea, while S. cinerea × viminalis proved less susceptible; and Salix viminalis L., S. purpurea L. and S. aurita × viminalis are not at all susceptible. According to Schneider the fungus on Salix incana Schr. with aecia also on Evonymus europaeus is not infective for Salix aurita, S. cinerea, S. nigricans, S. daphnoides, and other species; in some cases weak infections of S. caprea were reported.

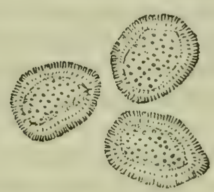


FIGURE 126. Melampsora evonymi-capREArum Kleb. on Evonymus latifolia Scop. Aeciospores, × 600. (Orig.)

FIGURE 127. Melampsora arctica Rostr. on Salix. Urediospores. (After Arthur)

4. Melampsora arctica Rostr., Medd. Groenland, III, 1888, p. 535; Sacc., Sylloge, VII, 1888, p. 595; IX, 1891, p. 296; Grove, Brit. Rust Fungi, 1913, p. 436; Trotter Fl. Ital. Crypt. Ured., 1914, p. 419; Syd., Monogr. Ured. III, 1915, p. 368, pr. p. (excl. aecidiis); Arth., N. Amer. Fl. VII, 1925, p. 669; Fragoso, Fl. Iber. Ured. II, 1925, p. 221, fig. 103, pr. p. (excl. aecidiis); Arth., Manual Rusts U. S. a. Canada, 1934, p. 56, fig. 81; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 158, pr. p.

Syn.: Uredo Rostrupiana Arth., N. Amer. Fl. VII, 1907, p. 100.

Melampsora alpina Juel., Öfvers. Kongl. Vet. Akad. Förhandl. 8, 1894, p. 417; Fischer, Ured. Schweiz, 1904, S. 491, Fig. 314; Klebahn, Wirtswechs. Rostpilze, 1904, S. 416; Hariot, Uréd., 1908, p. 262; Migula, Kryptog.-Fl.
338 Deutschl. III, 1, 1910, S. 480; Liro, Ured. Fenn., 1908, p. 546; Trotter, Fl. Ital. Crypt. Ured., 1914, p. 415; Syd., Monogr. Ured. III, 1915, p. 360; Fragoso, Fl. Iber. Ured., II, 1925, p. 225; Sacc., Sylloge, XIV, 1899, p. 289.

Uredo alpina Arth., Résult. scient. Congr. intern. bot. Vienne 1905, 1906, p. 338; N. Amer. Fl. VII, 1907, p. 99.

Caeoma saxifragae (Strauss) Winter, Pilze Deutschl., 1881, S. 258, pr. p.; Lindfors, Svensk Bot. Tidskrift, IV, 1910, p. 200, fig. 3.

Melampsora epitea (Kunze et Schm.) Thüm., Jørstad, Stud. on Kamtchatka Ured., 1934, p. 48, pr. p.

Biol. Jacky, Ber. Schweiz. bot. Ges. IX, 1899, S. 49; Klebahn, Ztschr. Pflanzenkr. XVII, 1907, S. 156.

Spermagonia scattered or in groups, conoidal, concave at the base, 150 — 160 μ wide, 90 — 130 μ high.

Aecia amphigenous, solitary, bright orange-red, 0.3 — 0.4 mm wide. Aeciospores globoid or ovoid, rarely slightly angular, 16.5 — 24.5 × 15 — 24 μ; walls colorless, 1.5 μ thick, verruculose. Paraphyses, mentioned in the diagnosis of Jacky (l. c.), could not be detected in the herbarium material examined.

Uredia amphigenous, single, round, about 0.5 mm in diameter, bright orange-yellow, later acquiring a brownish tint, covered first by the epidermis, later exposed. Urediospores globoid, obovoid, ellipsoid, 14 — 25 × 14 — 22 μ, (according to Jacky, 16 — 20 × 12 — 16 μ, and, according to Klebahn, 14 — 20 × 11 — 16 μ); walls colorless, 1.5 — 2.0 μ thick, finely echinulate. Paraphyses numerous, 36 — 61 μ long, capitate; caps 17 — 22 μ wide; walls colorless, 4 — 6 μ thick (Figure 127).

Telia amphigenous, subepidermal, small, usually single. Teliospores prismatic, rarely digitate, rounded or slightly pointed above, rarely flattened, and rounded or compressed below, 28 — 50 × 8 — 17 μ; walls thin, about 1 μ, pale brownish, slightly thickened at apex, not more than 1.5 μ; pore apical, inconspicuous.

Heteroecious. Aecia on Saxifraga oppositofolia L., apparently also on S. caespitosa L. and on other species of the same genus with the exception of S. aizoides (see Melampsora reticulatae Bl.). Uredio- and teliospores on Salix groenlandica, S. polaris, S. arctica, S. herbacea, and S. turczaninowii. The morphology of the fungus displays slight variations on the different host plants (see also Jørstad, Rep. Sci. Res. Norw. Exped. Novaja Zemlya, 1921, 18, 1923, p. 10). According to our observations Melampsora arctica Rostr. represents a heterogenous species breaking up into the following special forms, morphologically more or less differentiated.

Forma sp. alpina typica Kupr. Uredia mainly epiphyllous, scattered, 0.5 — 0.75 mm; urediospores globoid, ellipsoid, rarely ovoid, 13.5 — 22 × 13.5 — 24.5 μ; walls 1.5 μ thick, verrucose; paraphyses 36 — 61 μ long, capitate, their walls 4.5 — 6.0 μ thick. Teliospores as described above. Aecia on Saxifraga oppositifolia L., Uredio- and teliospores on Salix herbacea L. To this form should probably be referred also the fungus on Salix turczaninowii Laksch., with uredia on leaves and flowers.

339 Forma sp. arctica Kupr. Uredia mainly hypophyllous, rarely epiphyllous, usually solitary, round, about 1 mm wide, on rounded or angular yellow patches, markedly convex, light yellow; urediospores globoid, somewhat angular, ellipsoid, ovoid, 18 — 24 × 19 μ, up to 27 μ; walls verruculose, 1.5 — 3.5 μ thick; paraphyses 51 — 92 μ long, capitate, heads 18 — 36 μ, wall up to 6.1 μ thick. Teliospores as described above. Aecia apparently on Saxifraga oppositifolia L. Uredio- and teliospores on Salix arctica Pall., S. arctica × cuneata.

Forma sp. polaris Kupr. Uredia usually epiphyllous, rarely hypophyllous, solitary, frequently numerous, scattered along the entire frond, round, minute, 0.25 — 0.5 mm wide, pale yellow; urediospores ovoid, broad-ellipsoid, rarely globoid, prismatic or irregular, $18-28 \times 15.3-22\,\mu$; walls $2-3\,\mu$ thick, finely and densely verruculose; paraphyses $39-58\,\mu$ long, capitate, heads $15-21\,\mu$ wide, wall up to $6.5\,\mu$ thick. Telia in collections from Khibiny Mts. (Murmansk Region) mainly epiphyllous, subepidermal, minute, 0.12 — 0.33 mm, brown. Teliospores prismatic, broad-ellipsoid or digitate, rounded at both ends or flattened at the apex, occasionally divided into two cells by longitudinal septum easily perceptible when examined from above, rarely transversely septate, asymmetric, $18.5-48 \times 10-25\,\mu$; wall yellowish-brown, $1-2\,\mu$ thick, at apex usually thickened to $2.5\,\mu$; pore imperceptible. In collections from Novaya Zemlya teliospores $28-50 \times 6-12.5\,\mu$, of the same type. Aecia apparently on Saxifraga caespitosa and on other species; uredio- and teliospores on Salix polaris.

According to Lindfors (Svensk botanisk tidskrift, IV, 1910, p. 201), the aecia on Saxifraga oppositifolia and S. aizoides are distinguished from the aecia on S. cernua by the better developed paraphyses around the sori; Schneider-Orelli (Centrbl. Bakteriol. II, 1909, S. 439) points out that on S. aizoides the aeciospores have thicker walls than on S. varians. We failed to see any essential difference in structure between aeciospores on S. oppositifolia, S. muscoides, and S. caespitosa; the aeciospores on these three species of Saxifraga measure $16-24.5 \times 16-22\,\mu$, and are but slightly larger on S. aizoides: $18-28.5 \times 16.5-26\,\mu$.

General distribution: Europe (including the Caucasus), northern Asia, North America, Greenland.

On Saxifraga caespitosa L. — ARCTIC: Arc.-Eur. (Kolguev I.) Nov. Z. (in the vicinity of Matochkin Shar).

On Saxifraga oppositifolia L. — ARCTIC: Nov. Z. (Matochkin Shar).

On Saxifraga exilis Steph. — FAR EAST: Sakh. (Kuril Is.).

On (?) Saxifraga muscoides Wulf. — CAUCASUS: N Cauc. (moraines near Lake Syltran).

On Salix polaris Whlb. — ARCTIC: Nov. Z. (Matochkin Shar); EUROPEAN PART: Kar.-Lap. (vicinity of Kirovsk).

On Salix arctica Pall. — ARCTIC: Nov. Z. (Matochkin Shar).

On Salix arctica × cuneata — FAR EAST.

On Salix turczaninowii Laksch. — W SIBERIA: Alt. (pass between the Kalai and Usun rivers, tributaries of the Kara-Koksha, alpine meadows).

340 On Salix aquilonia Kimura — FAR EAST: Sakh. (Kuril Is.).

On Salix subreniformis Kimura — FAR EAST: Sakh. (Kuril Is.).

On Salix herbacea × myrsinites Wolf. — W SIBERIA: Irt.

In experimental infections performed by Jacky (l. c.) positive results were obtained by sowing aeciospores from Saxifraga oppositifolia on Salix herbacea; and negative results on Salix serpyllifolia, S. reticulata, S. retusa, and S. arbuscula. Teliospores from Salix herbacea sown on Saxifraga oppositifolia and on other species of Saxifraga were ineffective. Klebahn succeeded in infecting with aeciospores from Saxifraga sp. (removed in the vegetative state from Spitsbergen and not accurately determined): Salix herbacea, but not S. reticulata L., S. retusa L.,

S. myrsinites L., S. lanata L., and S. serpyllifolia L. The appearance of aecia in two consecutive years on the Saxifraga sp. from which the experiments were carried out led Klebahn to assume the presence of overwintering mycelium, for no specimens of Salix herbacea were found in the vicinity.

5. Melampsora reticulatae Blytt, Christiana Vid. Selsk. Förh. 6, 1896, p. 65; Sacc., Sylloge, XIV, 1899, p. 289; Liro, Ured. Fenn., 1908, p. 583; Trotter, Fl. Ital. Crypt. Ured., 1914, p. 416; Syd., Monogr. Ured. III, 1915, p. 362; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 158 (pr. p.).

Syn.: Uredo saxifragarum DC, Fl. franç. VI, 1815, p. 87, pr. p.

Caeoma saxifragarum auct. pr. p.

C. saxifragae Winter, Pilze Deutschl., 1881, S. 258, pr. p.

Melampsora epitea (Knze et Schm.) Thüm., Jørstad, A Study on Kamchatka Ured., 1934, p. 48, pr. p.

Spermagonia scattered or in groups, 90 — 125 μ high, about 150 μ wide, light orange-colored.

Aecia epiphyllous or amphigenous, solitary, usually scanty, 0.5 — 1.0 mm wide, orange-colored, surrounded by the torn epidermis. Aeciospores globoid, slightly angular, ovoid, rarely prismatic, 16 — 25 × 14 — 20 μ (in collections from Khibiny Mts., 18 — 28.5 × 16.5 — 26 μ); walls 2 — 3 μ thick, finely and densely verrucose.

Uredia hypophyllous, scattered or gregarious, round, about 0.5 mm wide, orange-tinted when fresh. Urediospores globoid, broad-ellipsoid, ovoid, rarely irregularly shaped, angular, prismatic, 17 — 27 × 15 — 19 μ (in collections from Khibiny Mts. 16 — 29 × 15 — 25 μ); walls 2.5 — 3.5 μ (according to our measurements, from 4 to 6 μ) thick, verrucose throughout. Paraphyses 60 — 95 μ (according to our measurements, from 35 to 64 μ) long, capitate, with the head width 18 — 30 μ, and walls up to 10 μ thick.

Telia hypophyllous, subepidermal, small, scattered, 0.3 — 0.5 mm wide, yellowish-brown at first, turning dark brown. Teliospores prismatic, wedge-shaped, rarely irregular, tapering downward, more or less rounded at both ends, 28 — 48 × 6 — 11 μ (according to Sydow, 35 — 40 × 10 - 13 μ); walls pale brown, 1 μ thick, thickened at the apex, to 2 μ; pore imperceptible (Figure 128).

Heteroecious. Aecia on Saxifraga aizoides L.; uredio- and teliospores on Salix reticulata. The fungus is distinguished from M. arctica Rostr. by larger urediospores and thicker spore walls, larger warts and wider paraphysal heads.

341 General distribution: Europe, northern Asia.

On Saxifraga aizoides L. — EUROPEAN PART: Kar.-Lap. (Khibiny Mts.).

On Saxifraga reticulata L. — EUROPEAN PART: Kar.-Lap. (Khibiny Mts.); W SIBERIA: Alt. (Altai Mts., Aktru Glacier, moraines, Alpine tundra).

The connection of aecia on Saxifraga aizoides with the uredio- and teliospores on Salix reticulata was confirmed by experimental infection (Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 158).

6. Melampsora yezoensis Miyabe et Mats., Matsumoto, Trans. Sapporo Nat. Hist. Soc. VI, 1, 1915, p. 8, fig. 1; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 155.

B i o l. Matsumoto, l. c., 1915, p. 7; Hiratsuka, Japan. Journ. Botany, VI, 1, 1932, p. 15.

Spermagonia not described.

Aecia hypophyllous, orange-yellow, on pale yellow round or somewhat angular patches, 2.5 — 5.0 mm wide. Aeciospores globoid or prismatic, ovoid, or angular, 15 — 20 × 12 — 17 μ; walls 1.5 — 2.5 μ thick, colorless, echinulate, with orange-yellow contents; pore imperceptible.

Uredia amphigenous, mostly hypophyllous, producing yellowish patches on the corresponding upper side, small, 0.3 — 1.0 mm, at first solitary, scattered, later numerous, occasionally covering the entire underside of the leaf, orange-yellow. Urediospores usually ovoid or ellipsoid, globoid, or prismatic, 18 — 29 × 13 — 17 μ; wall colorless, rather thick, 3 — 10 μ, echimulate, with no smooth spots; contents orange-yellow; pores imperceptible. Paraphyses 40 — 50 μ long, with rounded heads, 12 — 19 μ wide and rather thin pedicels.

Telia amphigenous, mostly epigenous, pale brown, later black-brown, scattered or confluent in groups, enclosed between the cuticle and epidermis. Teliospores usually cylindrical or wedge-shaped, rarely irregular, 20 — 30 × 8 — 12 μ; walls light brown, uniformly thin; not as strongly thickened at apex as in Melampsorea on Salix caprea L.; contents orange-yellow with numerous oil droplets.

Basidiospores globoid, 7 — 10 μ (according to Matsumoto).

Heteroecious. Aecia on **Corydalis ambigua** Cham. et Schltd.; uredio- and teliospores on **Salix jessoensis** Seem.; described from Japan (Sapporo). In the USSR possibly found in the Far East.

The aecial host was experimentally established by infection with basidiospores from Salix jessoensis (on Laris leptolepis Murr. no infection was obtained); reverse infection with aeciospores from **Corydalis ambigua** was obtained on **Salix jessoensis**, but not on **Salix daphnoides** Vill., **S. miyabeana** Seem., **S. opaca** Anders., **S. viminalis** L., and **S. caprea** L. (Matsumoso, l. c., p. 7). With aeciospores from the same plant Hiratsuka
342 (1932, p. 16) obtained infection of S. jessoensis, but not of **S. urbaniana**, **S. rorida** Laksch., and **S. sachalinensis** F. Schmidt.

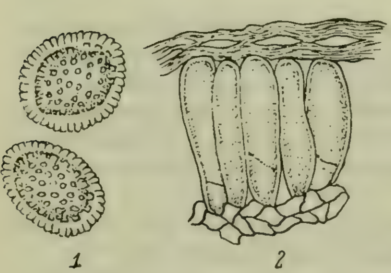


FIGURE 128. Melampsora reticulata Blytt on Salix reticulata L.:

1 — urediospores; 2 — teliospores; × 600. (Orig.)

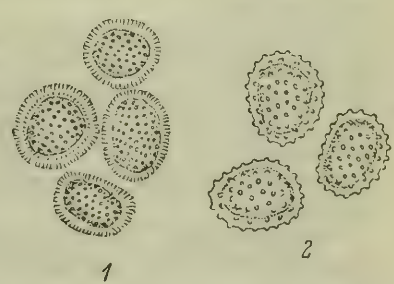


FIGURE 129. Melampsora abieti-capręarum Tub.:

1 — aeciospores on Abies sp.; 2 — urediospores on Salix caprea L., × 600. (Orig.)

7. **Melampsora abieti-caprearum** Tub., Centrbl. Bacteriol. II. Abt., IX, 1902, S. 241; Saccardo, Sylloge, XVII, 1905, p. 266, 462; Hariot, Uréd., 1908, p. 262; Migula, Kryptog.-Fl. Deutschl. III, 1, 1910, S. 478; Trotter, Fl. Ital. Crypt. Ured., 1914, p. 412; Klebahn, Kryptogfl. M. Brandb. Va, 1914, S. 792, 902; Syd. Monogr. Ured. III, 1915, p. 357; Fragoso, Fl. Iber. Ured. II, 1925, p. 220; Arth., Manual Rusts U. S. a. Canada, 1934, p. 55, fig. 79; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 157.

Syn.: Caeoma abietis pectinatae Rees, Abh. Nat. Ges. Halle, XI, 1869, S. 115; Winter, Pilze Deutschl., 1884, S. 257.

Melampsora Humboldtiana Speg., Ann. Mus. nat. Buenos-Aires, XXIII, 1912, p. 28; Arth., N. Amer. Fl. VII, 1924, p. 668; 1927, 814; Syd., Monogr. Ured. III, 1915, p. 366.

Biol. Tubeuf, Centrbl. Bacteriol. II. Abt., IX, 1902, S. 241; Naturwiss. Ztschr. Land- u. Forstwirtsch. III, 1905, S. 41; Mayor, Bull. Soc. mycol. France, XXXVI, 4, 1920, p. 191 — 203, fig. A — E; Bull. Soc. Neuchât. sci. natur. L, 1925, p. 91.

Spermagonia amphigenous, pale yellow, flanking the midrib, 70 — 115 μ wide, 58 — 70 μ high.

Aecia hypophyllous, produced in the same year, arranged in two rows (rarely one row) on light lines parallel to the midrib, solitary, round, 0.5 — 0.6 mm wide, frequently coalescing in stripes up to 8 — 10 mm long and 0.5 mm wide, light yellow, surrounded by the torn epidermis; the infected pale yellow leaves stand out sharply in the midst of the healthy ones. Aeciospores in chains, globoid, subgloboid, or somewhat angular, 14 — 17 μ (rarely 19 μ) across, occasionally slightly elongate and ellipsoid, 19 — 21 × 12 — 14 μ; walls colorless, on an average 1.5 μ thick, verrucose; warts conspicuous, rather large, at 1 μ intervals.

Uredia hypophyllous, scattered, numerous, single, small, early exposed, light yellow; correspond to small (0.5 mm) patches on the upper sides of leaf; in severe infections the patches coalesce, imparting a yellowish-green tint to the leaf; later, as the tissue atrophies, the patches and uredia become brown. Urediospores globoid or subgloboid, 13 — 15 μ across, occasionally somewhat elongate or pyriform, 16 — 19 × 12 — 14 μ; walls uniformly thick, about 1.5 μ, colorless, verrucose; warts small, at 1 μ intervals. Paraphyses capitate, up to 40 μ long; heads 16 — 24 μ wide, and 18 — 21 μ high; pedicel 4 — 5 μ wide; walls uniformly thick, 1.5 — 3 μ, slightly thickened at apex (Figure 129).

Telia hypophyllous, subepidermal, scattered in round blackish crusts, solitary, on an average 2 mm wide, more or less coalescing, numerous.
343 Teliospores light brown, elongate-ellipsoid, more or less prismatic, 21 — 30 × 9 — 12 μ (on Salix caprea), 19 — 26 × 9 — 12 μ (on S. aurita and S. cinerea), 19 — 28 × 9 — 12 μ (on S. incana); walls uniformly thick, about 1 μ, not thickened at apex (according to Mayor, l. c., 1920; described from cultures).

Heteroecious. Aecia on Abies pectinata DC, in cultures also on Abies pinsapo Boiss. (var. glauca), A. nordmanniana (Stev.) Spach., and A. cephalonica Loud.; uredio- and teliospores on Salix caprea L.

General distribution: western Europe.

In the USSR not detected; possibly introduced in the regions of fir distribution (Caucasus, Urals, etc.).

The connection of aecia on Abies with the uredio- and teliospores on Salix caprea was first established by Tubeuf. In cultures (according to Mayor, l. c.) the fungus passes onto Salix aurita, S. cinerea, S. incana, S. ingricans, S. purpurea, S. repens, and S. viminalis with the formation of teliospores; on S. arbuscula and S. helvetica production of urediospores alone was recorded.

8. M e l a m p s o r a o r c h i d i - r e p e n t i s (Plowr.) Kleb., Jahrb. wiss. Bot. XXXIV, 1900, S. 369, Fig. (S. 370); Fischer, Ured. Schweiz, 1904, S. 448; Saccardo, Sylloge, XVII, 1905, p. 463: Hariot, Uréd., 1908, p. 261; Grove, Brit. Rust Fungi, 1913, p. 343, fig. 259 (p. 344); Trotter, Fl. Ital. Crypt. Ured., 1914, p. 414; Klebahn, Kryptogfl. M. Brandb. Va, 1914, S. 802, Fig. O 19 (S. 812).

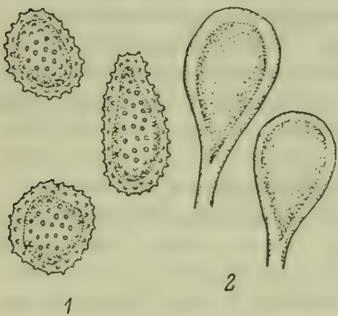


FIGURE 130. Melampsora orchidi-repentis (Plowr.) Kleb. on Salix rosmarinifolia L.:

1 – urediospores; 2 – teliospores; ×600. (Orig.)

Syn.: Melampsora repentis Plowr., Ztschr. Pflanzenkr. I, 1891, S. 131; Bubák, Rostpilze Böhmens, 1908, S. 199; Liro, Ured. Fenn., 1908, p. 544; Migula, Kryptog.-Fl. Deutschl. III, 1, 1910, S. 479; Syd., Monogr. Ured. III, 1915, p. 358; Fragoso, Fl. Iber. Ured. II, 1925, p. 228 (?); Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 158.

Caeoma orchidis (Mart.) Winter, Pilze Deutschl. I, 1884, S. 256.

Uredo repentis Arth., Result. scient. Congr. intern. bot. Vienne 1905, 1906, p. 338.

B i o l. Plowright, Ztschr. Pflanzenkr. I, 1891, S. 131; Klebahn, Jahrb. wiss. Bot. XXXIV, 1900, S. 369.

Spermagonia scarcely projecting, slightly raising the epidermis, with flat hymenium, about 170 μ wide, 80 μ high.

Aecia mainly hypophyllous, on pale yellow patches, in groups, usually arranged in rings, frequently confluent, rather large, 0.5 – 2.0 mm wide, 1 – 3 mm long, bright orange-yellow. Aeciospores ovoid or globoid, usually somewhat angular, $15-20 \times 11-15\,\mu$; walls thin, $1.0-1.5\,\mu$, finely verrucose; warts very discrete, $0.25-0.75\,\mu$ wide, at approximately 1 μ intervals.

Uredia hypophyllous rarely on Salix rosmarinifolia, small, 0.25 – 0.5 mm, when confluent, up to 1.5 mm, bright orange-colored, producing yellow spots on the upper side. Urediospores globoid or round-ovoid, $13-17 \times 12-14\,\mu$; walls about 1.5 μ thick, uniformly verrucose, warts at distances of approximately $1-5\,\mu$. Paraphyses usually capitate, $40-70\,\mu$ long; head $16-20\,\mu$, pedicels $3-5\,\mu$ wide, head wall $2-3\,\mu$ thick (Figure 130).

Telia hypophyllous, some also epiphyllous, subepidermal, small, dark
344 brown. Teliospores prismatic, rounded at both ends, rarely irregular, $18-48 \times 7-14\,\mu$; walls light brown, uniformly thick, about 1 μ; pore imperceptible.

Heteroecious. Aecia on Orchis maculata L. and O. latifolia L., probably also on other orchids (of genera Gymnadenia, Listera, Ophrys, Platanthera). Uredio- and teliospores on S. repens L. (incl. S. rosmarinifolia L.).

General distribution: Europe, Asia (Siberia).

On Listera ovata (L.) R. Br. — EUROPEAN PART: Lad.-Ilm.

On Gymnadenia-conopsea (L.) R. Br. — EUROPEAN PART: Lad.-Ilm., U. V.; W SIBERIA: U. Tob.

On Orchis sambucina L. — EUROPEAN PART: Lad.-Ilm.

On Orchis trausteineri Saut. — W SIBERIA: U. Tob.

On Orchis sp. — EUROPEAN PART: U. V.

On Ophrys muscifera Huds. — EUROPEAN PART: Lad.-Ilm.

On Salix rosmarinifolia L. — EUROPEAN PART: Lad.-Ilm., U. Dnp. (Minsk, Vitebsk), Balt.

The connection of aecia on Orchis with the uredio- and teliospores on Salix repens, L. (= S. rosmariniflora L.) was established by Plowright, and later experimentally confirmed by Klebahn. Development of aecia on Orchis maculata and O. latifolia was proved in cultures; the aecia on the other orchids were not experimentally proved to belong to the same fungal species.

9. **Melampsora ribesii-viminalis** Kleb., Jahrb. wiss. Bot. XXXIV, 1900, S. 363, Fig. (S. 367); Fischer, Ured. Schweiz, 1904, S. 494; Bubák, Rostpilze Böhmens, 1908, S. 201, Fig. 52; Hariot, Uréd., 1908, p. 262; Liro, Ured. Fenn., 1908, p. 550; Migula, Kryptog.-Fl. Deutschl. III, 1, 1910, S. 481; Grove, Brit. Rust Fungi, 1913, p. 342; Trotter, Fl. Ital. Crypt. Ured., 1914, p. 418; Klebahn, Kryptogfl. M. Brandb. Va, 1914, S. 788, Fig. O13 (S. 794); Syd., Monogr. Ured. III, 1915, p. 369, tab. XIV, fig. 142 (p. 351); Fragoso, Fl. Iber. Ured. II, 1925, p. 217; Sacc., Sylloge, XXIII, 1925, p. 838; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 156.

Syn.: Caeoma confluens Schroet., Pilze Schles., 1887, S. 376.

Uredo ribesii-viminalis Arth., Résult. scient. Congr. intern. bot. Vienne 1905, 1906, p. 338.

Biol. Klebahn, Jahrb. wiss. Bot. XXXIV, 1900, S. 363; XXXV, 1901, S. 662; Jahrb. Hamburg. wiss. Anst. XX, 1902, S. 16; Wirtswechs. Rostpilze, 1904, S. 419.

Spermagonia projecting like tubercles, with flat, slightly curved hymenium, 150 μ wide, 70 μ high.

Aecia hypophyllous, on yellow discolored spots, in groups up to 1.5 mm, bright orange-colored. Aeciospores usually globoid, rarely ovoid, somewhat angular, $18-23 \times 14-17\,\mu$; walls generally $2-3\,\mu$ thick,
345 thinner in many places and frequently with thicker spots (4 μ), with a structure of very short ridges of about 0.25 μ thick, at intervals of approximately 1 μ.

Uredia hypophyllous, minute, about 0.25 mm, in groups or scattered over the entire frond, pale orange-yellow. Urediospores usually globoid, rarely ovoid; $15-24 \times 14-20\,\mu$ (according to Klebahn, $15-19 \times 14-16\,\mu$); walls about 2 μ thick, uniformly covered by rather large warts at intervals of 2 μ. Paraphyses $50-70\,\mu$ long, partly capitate with thin, long pedicels; heads $18-20\,\mu$, pedicels $5-14\,\mu$ wide; walls $1-2\,\mu$ thick, occasionally slightly thicker in the region of the heads (Figure 131).

Telia epiphyllous, in the form of somewhat projecting crusts, small, 0.25 — 0.5 mm, scattered over the entire frond, often gregarious, dark brown. Teliospores prismatic, rounded at both ends, more or less irregular,

$25-40 \times 7-14\,\mu$; walls thin, about $1\,\mu$, light brown; pore not conspicuous. According to Klebahn, free teliospores are occasionally found in small sori on the underside of leaves; the spores are on short pedicels, unicellular, prismatic, $30-40\,\mu$ long, $11-14\,\mu$ thick, usually slightly narrowing at both ends, at the upper end often extending into an appendage resembling a bottleneck.

Heteroecious. Aecia on species of Ribes; uredio- and teliospores on Salix viminalis L.

General distribution: Europe.

On **Ribes rubrum** L. — EUROPEAN PART: U. Dns. (Lvov Region).

On **Ribes reclinatum** (L.) Mill. — EUROPEAN PART: Kar.-Lap.

On Ribes sp. (see **Melampsora ribesii-epitea** Kleb.).

On **Salix viminalis** L. — EUROPEAN PART: V.-Don (Syzran), Kar.-Lap.

In cultures Klebahn obtained aecia on **Ribes reclinatum** (L.) Mill., **R. rubrum**, L., **R. nigrum** L., **R. alpinum** L., and **R. aureum** Pursh; in cultures the fungus passes readily onto **Salix viminalis** L.; does not infect **Salix caprea** L., **S. aurita** L., **S. cinerea** L., **S. smithiana** Willd. (= **S. caprea** × **viminalis**), **S. amygdalina** L., **S. alba** L., **S. fragilis** L., **S. daphnoides** Vill., **S. purpurea** L., and other willow species.

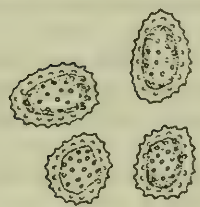


FIGURE 131. **Melampsora ribesii-viminalis** Kleb. on **Salix viminalis** L. Urediospores, ×600. (Orig.)

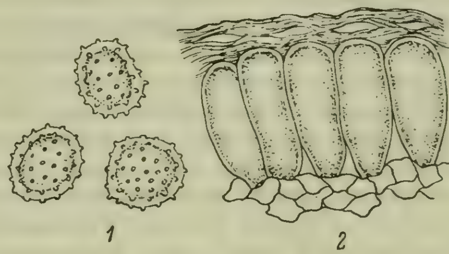


FIGURE 132. **Melampsora ribesii-epitea** Kleb. on **Salix purpurea** L.:

1 — urediospores; 2 — teliospores; ×600. (Orig.)

10. **Melampsora ribesii-epitea** Kleb. (S. l.), Kryptogfl. M. Brandb. Va, 1914, S. 796, Fig. 106 (S. 794).

Syn.: **Melampsora ribesii-salicum** Bubák, Rostpilze Böhmens, 1908, S. 200; Migula, Kryptog.-Fl. Deutschl. III, 1, 1910, S. 481; Trotter, Fl. Ital. Crypt. Ured., 1914, p. 417; Sacc., Sylloge, XXIII, 1925, p. 838.

M. ribesii-purpureae Kleb., l. c., p. 796; Syd., Monogr. Ured. III, 1915, p. 363.

M. confluens (Pers.) Jackson, Brookl. Bot. Gard. Mem. I, 1918, p. 210; Arth., N. Amer. Fl. VII, 1924 (1926), p. 668 (814).

Spermagonia about $150\,\mu$ wide and $60\,\mu$ high.

Aecia hypophyllous, single or in groups on yellowed patches, 0.5—1.5 mm. orange-colored. Aeciospores usually globoid, rarely angular, single, elongate, $17-24 \times 15-20\,\mu$; walls up to $3\,\mu$ thick, usually with thickened spots, verruculose, verrucules less than $0.5\,\mu$ wide, at approximately $1\,\mu$

346 intervals. Aeciospores on different species of Ribes are slightly different: on Ribes alpinum L. (Leningrad Region) and R. nigrum L. (Tomsk Region) 16.2 – 26.5 × 16.2 – 20.5 μ, almost smooth, shagreenlike; on R. diacantha Pall. (Buryat-Mongol ASSR) the spores are of the same size as on R. alpinum but markedly verrucose; on R. reclinatum (L.) Mill. (Jaap, No. 525) 19 – 24.5 × 14.2 – 22 μ, finely verruculose; on R. meyeri Max. (Uzbek SSR), 15.1 – 20.3 × 12.3 – 20.1 μ, small but clearly verrucose.

Uredia hypophyllous, producing bright yellow spots, small, 0.5 mm, occasionally up to 1 mm, round, convex. Urediospores globoid, rarely slightly angular, 16 – 20 × 14 – 18 μ, walls rather thick, 3 – 3.5 μ, thinner in places, sparsely verrucose (warts at 2 μ intervals). Paraphyses 55 – 70 μ long, usually capitate with thin pedicels (heads 16 – 24 μ, pedicels 4 – 7 μ thick), occasionally digitate; walls uniformly thick, 2.5 – 4.0 μ (rarely 5 μ).

Telia hypophyllous, subepidermal, single and in groups, small, up to 0.5 mm, at times densely covering considerable portions of the leaf surface, brown, causing browning of leaves on both sides. Teliospores irregularly prismatic, rounded at both ends, 20 – 30 × 7 – 11 μ; walls light brown, thin, about 1 μ, without thickenings; pores scarcely perceptible, if at all. (The description corresponds to the fungal form on Salix aurita) (Figure 132).

Heteroecious. Aecia on species of Ribes; uredio- and teliospores on Salix aurita L., S. grandifolia Seringe, and S. purpurea L. The species composition comprises forms biologically close or identical, but more or less specialized in their relationship to the host.

Forma sp. ribesii-auritae Kupr. (Klebahn (sub sp.) Jahrb. wiss. Bot. XXXV, 1901, S. 668, Fig. II (S. 670); Fischer, Ured. Schweiz, 1904, S. 493; Hariot, Uréd., 1908, p. 262; Liro, Ured. Fenn., 1908, p. 547; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 157).

Biol. Klebahn, Ztschr. Pflanzenkr. XII, 1902, S. 30; Jahrb. Hamburg. wiss. Anst. XX, 1902, S. 14; Wirtswechs. Rostpilze, 1904, S. 424.

Aecia on Ribes nigrum L., in cultures also on Ribes reclinatum (L.) Mill., R. alpinum L., R. aureum Pursh. Uredio- and teliospores on Salix aurita L. The fungus is scarcely transferred in cultures onto S. caprea L. and S. cinerea L., and not at all onto S. purpurea L.

Forma sp. ribesii-grandifoliae Schneider, Centrbl. Bacteriol. II. Abt., XV, 1905, S. 233.

Biol. Schneider, Centrbl. Bacteriol. II. Abt., XVI, 1906, S. 92, 169.

Aecia obtained in cultures on Ribes alpinum L. (weakly) infect R. aureum Pursh and R. sanguineum Pursh; apparently fail to infect R. reclinatum (L.) Mill., R. rubrum L., and R. nigrum L. Uredio- and teliospores on Salix grandifolia Seringe. In cultures weakly infects S. aurita L., and even less S. arbuscula L.; it does not pass onto S. viminalis,
347 S. purpurea, S. cinerea, S. caprea, S. daphnoides, S. fragilis, S. incana, S. nigricans, etc.

Forma sp. ribesii-purpureae Kupr. (Kleb. (sub sp.), Jahrb. wiss. Bot. XXXV, 1900, S. 667, Fig. I, S. 666; Syd., l. c.; Fischer, Ured. Schweiz, 1904, S 492; Hariot, Uréd., 1908, p. 262; Liro, Ured. Fenn., 1908, p. 550; Grove, Brit. Rust Fungi, 1913, p. 342; Klebahn, Kryptogfl. M. Brandb. Va, 1914, S. 796, Fig. O16 (S. 794); Fragoso, Fl. Iber. Ured. II, 1925, p. 222, fig. 104; Arth., Manual Rusts U. S. a. Canada, 1934, p. 55, fig. 80; Tranzschel Consp. Ured. URSS, Moscow, 1939, p. 157).

Biol. Klebahn, l. c.; Jahrb. Hamburg. wiss. Anst. II, 1902, S. 17; Ztschr. Pflanzenkr. XII, 1902, S. 31; Wirtswechs. Rostpilze, 1904, S. 424.

Spermagonia with flat hymenium, about 180μ wide, 60 – 70μ high. Aeciospores 15 – 23 × 12 – 19μ, mostly 18 – 20 × 15 – 18μ; walls verrucose; warts flat, low, 1 – 2μ wide, at 1.0 – 1.5μ intervals. Urediospores 15 – 23 × 14 – 19μ, usually globoid, rarely somewhat angular, paraphyses 40 – 70μ long, walls uniformly thick, 1.5 – 3.0μ. Telia amphigenous, more abundant on the underside, small, 0.25 – 0.5 mm, black-brown; teliospores 25 – 35 × 7 – 10μ; pore imperceptible. Is distinguished from the former two forms by larger warts on aeciospores, and amphigenous development of the teliospores.

In cultures aecia have been obtained on Ribes **reclinata** (L.) Mill., R. **alpinum** L., R. **aureum** Pursh., R. **sanguineum** Pursh.; not on R. **rubrum** L. or R. **nigrum** L. Uredio- and teliospores on Salix **purpurea** L.; in cultures rather strongly infecting S. **purpurea** × **viminalis**, less infective for S. **daphnoides** Vill., and not at all for S. **cinerea** L.; in most cases also infective on S. **aurita** L. and S. **viminalis** L.

General distribution: Europe, Asia (Central Asia, Siberia), North America.

On Ribes **alpinum** L. — EUROPEAN PART: Lad.-Ilm., Balt.

On Ribes **nigrum** L. — EUROPEAN PART: Dv.-Pech., M. Dnp., U. Dns. (Ternopol' Region); W SIBERIA: Ob (Khanty-Mansi National District), Irt.

On Ribes **diacanthum** Pall. — E SIBERIA: Dau.

On Ribes **meyeri** Max. — CENTRAL ASIA: Syr D. (Sydow in Monogr. Ured. III, p. 364, indicates Ribes **atropurpureum** C. A. M. for Siberia).

On Salix **daphnoides** Vill. — EUROPEAN PART: Balt. (Riga Subregion).

The specialization of the fungus was thoroughly studied in cultures (Klebahn, Schneider); apparently, all three forms may produce aecia on Ribes **alpinum** L. and R. **aureum** Pursh.

11. **Melampsora lapponum** Lindfors, Svensk Bot. Tidskrift, VII, 1913, p. 48, fig. 1 – 3; Syd., Monogr. Ured. III, 1915, p. 364; Sacc., Sylloge, XXIII, 1925, p. 833; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 157.

Syn.: **Caeoma violae** Lindfors, Svensk Bot. Tidskrift, IV, 3, 1910, p. 198, fig. 2 (p. 199).

Spermagonia not described.

Aecia hypophyllous, in round groups, 2 – 5 mm across, disposed loosely or in rings 0.5 – 1.0 mm in diameter, orange-colored. Aeciospores globoid or ellipsoid, sparsely and coarsely verrucose, 18 – 27 × 17 – 20μ: walls 2 – 2.5μ thick.

348

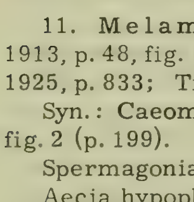


FIGURE 133. Melampsora lapponum Lindfors on Salix lapponum L. Urediospores, ×600. (Orig.)

Uredia hypophyllous, minute, 0.25 mm in diameter, yellow. Urediospores globoid, ovoid to ellipsoid, occasionally somewhat angular, evenly verrucose, 14 – 23 × 11 – 20μ (usually 20 – 21 × 15 – 16μ). Paraphyses mostly bordering the sori, digitate or capitate, colorless; heads 12 – 30μ wide, walls 1 – 4μ thick (Figure 133).

Telia usually epiphyllous, subepidermal, small, 0.25 – 0.5 mm across, dark brown. Teliospores prismatic, rounded at both ends, 30 – 50 × 6 – 12μ; walls thin, without apical thickening, brown; pore imperceptible.

Heteroecious. Aecia on Viola **epipsila**; uredio- and teliospores on Salix **lapponum** L. The fungus was

described from Swedish Lapland; it might be found in the northern regions of the USSR.

On (?) Salix lapponum L. — EUROPEAN PART: Lad.-Ilm. (near the shores of Lake Ladoga); W SIBERIA: Ob (Khanty-Mansi National District: Berezovo District (in both cases only II)).

The host of the aecial stage was established by experimental infections of S. lapponum with aeciospores from Viola epipsila (Lindfors, 1913, p. 47).

11a. Melampsora bigelowii Thüm., Mitt. forstl. Versuchsw. Österreichs, II, 1879, S. 37; Sacc., Sylloge, VII, 1888, p. 595; Arth., Journ. Mycology, XI, 1905, p. 60; Manual Rusts U. S. a. Canada, 1934, p. 54, fig. 78; Syd., Monogr. Ured. III, 1915, p. 365.

Syn.: Lecythea macrosora Peck, Bot. Gaz. V. 1880, p. 35.

Uredo Bigelowii Arth., Résult. scient. Congr. intern. bot. Vienne 1905, 1906, p. 338; N. Amer. Fl. VII, 1907, p. 100.

Melampsora paradoxa Diet. et Holway, Hedwigia, XL, 1901, S. (32); Sacc., Sylloge, XVI, 1902, p. 118.

Biol. Arthur, Journ. Mycology, XI, 1905, p. 60; XIII, 13, 1907, p. 194; Weir a. Hubert, Phytopathology, VI, 1916, p. 372; VII, 1917, p. 109.

Spermagonia amphigenous, small, subepidermal.

Aecia mostly hypophyllous, small, pale orange-colored.

Aeciospores globoid, $15-22 \times 18-27\mu$; walls colorless, $2-3\mu$ thick, delicately verrucose.

Uredia mainly hypophyllous, scattered over entire leaf surface, 0.3 — 1.0 mm wide, sometimes confluent, from round to oval, orange-yellow, producing yellowish patches on the corresponding side of the leaf. Urediospores globoid, ellipsoid, or ovoid, $15-20 \times 17-24\mu$, verrucose; walls colorless, $2.6-3.5\mu$ thick. Paraphyses capitate, $50-70\mu$ long.

Telia amphigenous, frequently confluent, orange-yellow, later reddish-brown, covered by the epidermis. Teliospores prismatic, elongate, not thickened at apex, $29-43 \times 11-14\mu$; walls 1μ thick, brown.

Heteroecious. Aecia on species of Larix, uredio- and teliospores on species of Salix in North America. May be found in the USSR (see Salix myrtilloides L., p. 370).

Connection of the fungus with Larix decidua Mill., L. americana Michx., and L. occidentalis Nutt. was experimentally established by Arthur, Weir and Hubert (l. c.).

349 12. Melampsora chelidonii-pierotii Mats., Bot. Mag. Tokyo XL, 1926, p. 46, fig. 1, 2; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 157.

Spermagonia hypophyllous in round yellowish groups.

Aecia hypophyllous, occasionally caulicolous, single or in groups, producing yellow patches on the upper side of the leaf, round or elongate, 1 — 2 mm wide, frequently coalescing in irregular patches, up to 5 mm, orange-red. Aeciospores globoid or ovoid, sometimes angular-globoid, finely and densely echinulate, $13-19 \times 12-15\mu$; walls 1μ thick.

Uredia amphigenous, mainly hypophyllous, scattered over entire surface, orange-yellow. Urediospores ovoid or ellipsoid, $16-23 \times 13-16\mu$; walls colorless, $2-3\mu$, rather sparingly and coarsely echinulate. Paraphyses capitate, $30-65\mu$ long, with thin pedicels; head $18-22 \times 20-25\mu$; wall thickened at the apex up to 12μ.

Telia amphigenous, more abundant on the upper side, reddish-brown, scattered over entire surface, 96 — 480 μ across, situated between the cuticle and epidermis. Teliospores cylindrical to wedge-shaped, 20 — 64 × 6 — 8 μ; wall uniformly thick; pore imperceptible.

Aecia on Chelidonium majus L. and Corydalis incisa Pers.; uredio- and teliospores on Salix pierotii Miq. The fungus was described from Japan (Morioka). May be found in the Soviet Far East.

In experiments carried out by Matsumoto Salix pierotii was infected with aeciospores from Chelidonium majus and Corydalis incisa, whereas Salix babylonica was not susceptible. Basidiospores from Salix pierotii caused infection of Chelidonium majus and Corydalis incisa, but not of Larix leptolepis (Matsumoto, l. c., p. 44, 45).

13. **Melampsora larici-epitea** Kleb., Ztschr. Pflanzenkr. IX, 1899, S. 88, Fig. (S. 96 — 98); Fischer, Ured. Schweiz, 1904, S. 485, Fig. 313; Bubák, Rostpilze Böhmens, 1908, S. 197, Fig. 51; Hariot, Uréd., 1908, p. 261; Liro, Ured. Fenn., 1908, p. 551; Migula, Kryptog.-Fl. Deutschl. III, 1, 1910, S. 478, Taf. XI B, Fig. 7 — 9; Grove, Brit. Rust Fungi, 1913, p. 340, fig. 257, 258; Trotter, Fl. Ital. Crypt. Ured., 1914, p. 412, fig. 106; Klebahn, Kryptogfl. M. Brandb. Va, 1914, S. 790, Fig. O14 (S. 790); Syd., Monogr. Ured. III, 1915, p. 355; Fragoso, Fl. Iber. Ured. II, 1925, p. 218, fig. 102; Sacc., Sylloge, XXIII, 1925, p. 826; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 157.

Syn.: Caeoma laricis Hartig., Wichtige Krankh. d. Waldbäume, 1874, S. 93, pr. p.

Uredo larici-epitea Arth., Résult. scient. Congr. intern. bot. Vienne 1905, 1906, p. 338.

Biol. Klebahn. Ztschr. Pflanzenkr. IX, 1899, S. 88, Fig. (S. 96, 98); XII, 1902, S. 34; XV, 1905, S. 104; XVII, 1907, S. 155; Jahrb. wiss. Bot. XXXIV, 1900, S. 371, Fig. (S. 358); XXXV, 1901, S. 682; Jahrb. Hamburg. wiss. Anst. XX, 1902, S. 10; Wirtswechs. Rostpilze, 1904, S. 420; Ed. Fischer, O. Schneider, Matsumoto, Hiratsuka — see below.

Spermagonia subcuticular round-conoid, 70 — 100 μ wide, 30 — 40 μ high.

Aecia hypophyllous, single or in rows, with corresponding yellow spots on the upper side of the leaf, round or elongate, 0.5 — 1.5 mm long, pale
350 orange-colored; aecia of the fungus on Salix retusa are surrounded by a crown of capitate, thin-walled paraphyses. Aeciospores globoid, ellipsoid, or slightly angular, 15 — 25 × 10 — 21 μ; walls about 1.5 — 3.0 μ thick, with a delicate, sparse, very short-ridged structure about 0.5 μ thick, at intervals of approximately 1 μ.

Uredia either amphigenous or confined to the upper or lower side of the leaves, on yellow spots, 0.25 — 1.5 mm, orange-yellow. Urediospores usually ovoid or slightly prismatic, globoid or angular, 12 — 25 × 9 — 19 μ, slightly varying on different host plants; walls rather thick, 1.5 — 3.5 μ, sparingly verrucose (warts at 2 — 3 μ intervals). Paraphyses capitate, 35 — 80 μ long, head-width 15 — 24 μ; wall thickness 3 — 5 μ, increasing in the region of the heads to 10 μ (Figure 134).

Telia generally hypophyllous, on Salix retusa, S. miyabeana, S. opaca also epiphyllous; subepidermal, dark brown, sometimes tinged with violet, small, 0.25 — 1.0 mm, often closely packed or coalescing in small groups covering portions of the blade delimited by the small veins. Teliospores

prismatic, wedge-shaped or irregular, usually rounded at both ends, $20-50 \times 7-14\mu$; walls light brown, uniformly thin, about 1μ; pore imperceptible.

Heteroecious. Aecia on species of Larix. Uredio- and teliospores on numerous species of Salix (comprising ten sections). Heterogenous species break up into closely related biological forms adapted to definite hosts.

Forma sp. larici-epitea typica Kleb., Kryptogfl. M. Brandb. Va, 1914, S. 790, 793. Aeciospores $15-21 \times 10-18\mu$, walls about 1.5μ thick; urediospores ovoid, globoid, or angular, $13-25 \times 9-19\mu$, walls $1.5-2.5\mu$ thick, verrucose, at 2μ intervals; teliospores only hypophyllous.

On Salix viminalis L., S. cinerea L., S. aurita L., S. amygdalina $\times$ viminalis. In cultures it readily passes onto S. caprea L., less onto S. acutifolia Willd., S. daphnoides Vill. (Klebahn, l. c.).

Forma sp. larici-daphnoides Kleb., Kryptogfl. M. Brandb. Va, 1914, S. 791, 793. Aeciospores $17-21 \times 12-16\mu$, walls $1.5-2.5\mu$ thick; urediospores oval or slightly prismatic, often somewhat tapering downward, $16-23 \times 12-14\mu$, walls $2.5-3.5\mu$ thick, verrucules at $2.5-3\mu$ intervals; teliospores only hypophyllous.

On Salix daphnoides Vill., S. acutifolia Willd. In cultures it readily passes onto the above-mentioned species, scarcely infecting S. cinerea L. and S. aurita L., and not infecting S. viminalis L. (Klebahn, l. c.).

Forma sp. larici-retusae Ed. Fisch. Ured. Schweiz, 1904, S. 487; Ber. Schweiz. bot. Ges. XIV, 1904, S. 5, Fig. p. 10; XV, 1905; Schneider, Centrbl. Bacteriol. II, Abt., XVI, 1906, S. 164; Klebahn, Kryptogfl. M. Brandb. Va, 1914, S. 791, 793. Aeciospores $18-25 \times 14-21\mu$, walls $2-3\mu$ thick;
351 aecia surrounded by a crown of capitate paraphyses; urediospores $18-22 \times 14-18\mu$, walls about 2μ thick, verrucae at 2μ intervals; teliospores amphigenous.

On Salix retusa L. In cultures it infects S. reticulata L. and S. serpyllifolia Scop. (Fischer, 1904, S. 9), as well as S. caprea L.; very weak infections were obtained on S. aurita L. and S. cinerea L. (Klebahn, Ztschr. Pflanzenkr. XI, 1905), and none at all on S. acutifolia Willd. and S. daphnoides Vill. (Schneider, 1906, S. 165).

Forma sp. larici-nigricantis O. Schneider, Centrbl. Bakteriol. II. Abt., XIII, 1904, S. 233; XVI, 1906, S. 77, 166.

The morphological characteristics of the fungus have not been accurately studied. Occurs on Salix nigricans Sm. Enand. In cultures it infects Salix glabra Scop., S. Hegetschweileri Heer; less S. cinerea L., S. acutifolia Willd., S. daphnoides Vill., S. arbuscula L., S. incana Schrank.; and not at all S. aurita L., S. repens L., S. purpurea L., S. viminalis L., S. retusa L., etc.

Forma sp. larici-purpurea O. Schneider, Centrbl. Bakteriol. II. Abt., XIII, S. 223, 1904; XVI, 1906, S. 80, 166.

The morphology of the fungus is not known in detail. Occurs on Salix purpurea L. In cultures it infects S. daphnoides Vill., S. aurita L., slightly S. cinerea L., S. nigricans (Sm.) Enand., S. incana Schr., S. grandifolia Ser.; and not at all S. viminalis L., S. hegetschweileri, S. reticulata L., S. herbacea L., etc. The fungus is biologically closely related to f. sp. larici-daphnoides Kleb.

Forma sp. larici-reticulatae O. Schneider, Centrbl. Bakteriol. II. Abt., XV, 1905, S. 233; XVI, 1906, S. 85, 167.

The morphology of the fungus has not been accurately studied. Occurs on S. reticulata L. In cultures it readily passes onto S. hastata L., weakly infecting S. herbacea L., not at all S. retusa, S. serpyllifolia Scop., S. daphnoides Vill., S. acutifolia Willd., S. caprea L., S. aurita L., S. cinerea L., S. nigricans (Sm.) Enand., S. incana Schr., S. purpurea L., S. viminalis L., S. arbuscula L., S. fragilis L., S. amygdalina L., etc.

Forma sp. larici-miyabeana Kupr. (Miyabe et Matsumoto (species), Matsumoto, Trans. Sapporo Nat. Hist. Soc. VI, 1, 1915, p. 9, fig. 2; Hirats., Japan. Journ. Botany, VI, 1, 1932, p. 10). Aeciospores $15-22 \times 12-16\mu$; uredia amphigenous, mostly hypophyllous; urediospores $15-21 \times 12-15\mu$; telia amphigenous, usually hypophyllous, scattered or coalescing in groups; teliospores wedge-shaped or prismatic, $20-40 \times 7-10\mu$; basidiospores globoid, $8-10\mu$ (according to Matsumoto, l. c.).

Aecia on Larix europaea DC, L. leptolepis Murr.; uredio- and teliospores on Salix miyabeana Seem. In cultures it readily infects S. miyabeana; does not infect S. daphnoides Vill., S. viminalis L., S. opaca Anders. (Matsumoto, l. c., p. 5). According to Hiratsuka (l. c., pp. 6, 7), basidiospores from S. miyabeana readily infect Larix kaempferi, producing aeciospores, which severely infect Salix miyabeana, rather weakly S. rorida Lacks., and not at all Salix bakko Kimura, S. jessoensis Seem., and S. sachalinensis Schm. The fungus is described as a species; morphologically it is indistinguishable from a series of forms found in the composition of Melampsora larici-epitea Kleb.

Forma sp. larici-opaca Kupr. (Miyabe et Matsumoto (species), Matsumoto, Trans. Sapporo Nat. Hist. Soc. VI, Pl. 1, 1915, p. 10, fig. 3; Hirats., Japan. Journ. Botany, VI, 1932, p. 10). Aeciospores $15-20 \times 12-15\mu$;
352 uredia hypophyllous; urediospores $12-19 \times 11-15\mu$; telia hypophyllous, scattered or coalescing in groups; teliospores prismatic or wedge-shaped, $26-37 \times 8-13\mu$ (according to Matsumoto, l. c.).

Morphologically it is identical with the preceding forms. Aecia on Larix europaea DC., L. leptolepis Gord.; uredio- and teliospores on S. opaca Anders. In cultures it passes onto S. viminalis, but not onto Salix daphnoides Vill. and S. miyabeana Seem. (Matsumoto, l. c., p. 6). According to Hiratsuka the fungus on S. sachalinensis Schmidt (=S. opaca Anders., according to Hiratsuka, which is incorrect, see Flora of the USSR, V, 1936, pp. 144, 148) with aecia on Larix kaempferi should also be referred to this form; in cultures it does not pass onto S. bakko, S. jessoensis, S. miyabeana, S. rorida, etc. (Hiratsuka, l. c., pp. 7–10).

General distribution: Europe, northern and Middle Asia.

On Larix (see Caeoma laricis).

On Salix viminalis L. — EUROPEAN PART: Urals, Transv., Balt.; W SIBERIA: Ob, Alt.; E SIBERIA: Lena-Kol.

On Salix viminalis × caprea — CENTRAL ASIA: Lake Balkhash area.

On Salix daphnoides Vill. — EUROPEAN PART: U.V.; Lad.-Ilm. (Kalinin Region: Opochka Subregion), Transv., V.-Kama, U. Dnp.; CENTRAL ASIA: Syr D.

On Salix acutifolia Willd. — EUROPEAN PART: Lad.-Ilm., Crim., Bl., U. Dnp.

On Salix nigricans (Sm.) Enand. — EUROPEAN PART: Lad.-Ilm., Kar.-Lap., V.-Don, U. V., V.-Kama, U. Dnp., Balt., Dv.-Pech.; W SIBERIA: Ob.

On Salix sachalinensis F. Schmidt. — FAR EAST: Sakh. (S Sakhalin).

On Salix purpurea X viminalis — EUROPEAN PART: Balt.

On Salix sp. — EUROPEAN PART: Lad.-Ilm.; CENTRAL ASIA: Syr D. (Tashkent).

The degree of adaptation of the described forms varies in relation to certain hosts; some forms, such as f. sp. larici-epitea typica, f. sp. larici-daphnoides, and f. sp. larici-purpurea apparently include fungi with a wider amplitude of specialization (compare Klebahn, Wirtswechs. Rostpilze, p. 422); other forms, described from the Far East, are distinguished by a narrower specialization. The forms listed above scarcely differ in their morphology, except for f. sp. larici-retusae, which closely resembles Melampsora arctica Rostr.

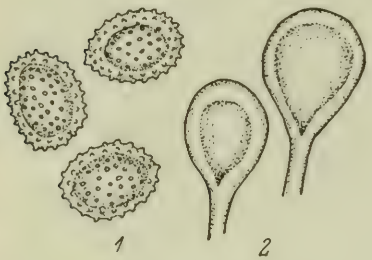


FIGURE 134. Melampsora larici-epitea Kleb. on Salix viminalis L. s. l. :

1 — urediospores; 2 — paraphyses. × 600. (Orig.)

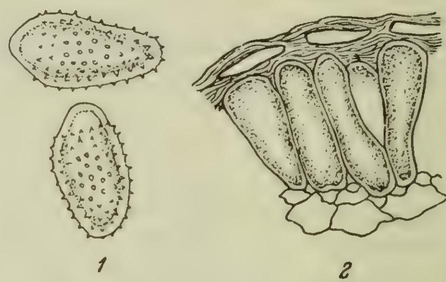


FIGURE 135. Melampsora larici-pentandrae Kleb. on Salix pentandra L.:

1 — urediospores; 2 — teliospores. × 600. (Orig.)

14. Melampsora larici-pentandrae Kleb., Ztschr. Pflanzenkr. VII, 1897, S. 330, Fig. 1—5 (S. 331); Fischer, Ured. Schweiz, 1904, S. 479; Hariot, Uréd., 1908, p. 260; Liro, Ured. Fenn., 1908, p. 539; Trotter, Fl. Ital. Crypt. Ured., 1914, p. 408; Klebahn, Kryptogfl. M. Brandb. Va, 1914, S. 777, Fig. O8 (S. 782); Syd., Monogr. Ured. III, 1915, p. 370, tab. XIV, fig. 143; Sacc., Sylloge, XXIII, 1925, p. 837; Fragoso, Fl. Iber. Ured. II, 1925, p. 209; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 155.

Syn.: Uredo minutissima Opiz in Seznam, 1852, p. 152.

U. larici-pentandrae Arth., Résult. scient. Congr. intern. bot. Vienne 1905, 1906, p. 338.

Caeoma laricis Hartig in Wichtige Krankh. d. Waldbaüme, 1874, S. 93.

Melampsora minutissima (Opiz) Bubák, Rostpilze Böhmens, 1908, S. 149;
353 Migula, Kryptog.-Fl. Deutschl. III, 1, 1910, S. 476.

Biol. Klebahn, Ztschr. Pflanzenkr. VII, 1897, S. 330; IX, 1899, S. 137; XII, 1902, S. 38; Jahrb. wiss. Bot. XXXV, 1901, S. 686; Jahrb. Hamburg. wiss. Anst. XX, 1902, S. 3; Wirtswechs. Rostpilze, 1904, S. 415.

Spermagonia blunt-conoid, subcuticular, 60—100 μ wide, 30—50 μ high, usually epiphyllous.

Aecia mostly hypophyllous, 0.25 mm wide, to 1 mm long, bright orange-colored, scattered on yellowed patches. Aeciospores in short chains (with the

intermediate cells soon becoming imperceptible), ovoid, globoid, or slightly angular, 18 — 26 × 13 — 20 μ; spore wall 1.5 — 2.0 μ thick; ridged structure; ridges very short, 0.5 μ thick, at approximately 0.75 μ intervals. The aecia are differentiated by the bright orange-yellow tints from those of M. larici-caprearum and M. larici tremulae produced on the same hosts and pale orange-colored.

Uredia hypophyllous, occasionally scattered over the entire underside with some also on the upper side of the leaves, forming bright orange patches, up to 1 mm. Urediospores for the most part digitate, rarely oblong-ellipsoid or ovoid, frequently very long, 26 — 44 × 12 — 16 μ; walls about 2 μ thick, perfectly smooth at the apex, slightly flexed at the lower part, rarely verrucose; verrucules at intervals of 2 — 2.5 μ. Paraphyses up to 50 μ long with rounded heads from 12 — 22 μ in diameter on thin (4 — 5 μ) pedicels.

Telia hypophyllous, subepidermal, small, 0.5 mm, frequently coalescing in a continuous crust covering the entire leaf surface. Yellowish-brown, later dark brown. Teliospores prismatic, 28 — 38 × 6 — 11 μ; spore walls light brown, about 1 μ thick, not thickened at the apex (Figure 135).

Heteroecious. Aecia on **Larix decidua** Mill. in the spring; in cultures also on **Larix sibirica** Ldb. Uredio- and teliospores on **Salix pentandra** L.; in cultures the fungus is transmitted to **Salix fragilis × pentandra** and **S. fragilis**.

General distribution: Europe, Central Asia.

No aecia are found in the USSR collections, see **Caeoma laricis** (West) Hart.

On **Salix pentandra** L. — EUROPEAN PART: Dv.-Pech. (Kargopol'), Kar.-Lap., Lad.-Ilm., U. V., V.-Kama (Kirov Region, Molotov Region: Molotov), Transv. (Ufa), U. Dnp. (Chernigov Region: Nezhin), M. Dnp. (Poltava), V.-Don (Tambov, Saratov), Balt., Bl. (Dnepropetrovsk); W SIBERIA: Ob (Tomsk), Alt.; E SIBERIA: Ang.-Say. (Minusinsk, Irkutsk); FAR EAST: Kamch.

According to Klebahn (l. c.), basidiospores from Salix pentandra L. infect Larix decidua Mill. and L. sibirica Ldb. Aeciospores from L. decidua infect S. pentandra L., S. fragilis L., S. fragilis × pentandra; but not
354 S. amygdalina L., S. alba L., S. amygdalina × viminalis. In one experiment basidiospores from S. pentandra infected in addition to Larix decidua also Allium vineale L. and A. cepa L. Klebahn attributed this occurrence to the presence on the leaves of S. pentandra of a teliospore mixture of M. larici-pentandrae Kleb. and M. allii-fragilis Kleb. (Klebahn, 1902).

15. **Melampsora allii-salicis albae** Kleb., Ztschr. Pflanzenkr. XII, 1902, S. 19, Fig. 1 (1 — 5) (S. 22); Fischer, Ured. Schweiz, 1904, S. 480; Sacc., Sylloge, XVII, 1905, p. 266; Hariot, Uréd., 1908, p. 260; Liro, Ured. Fenn., 1908, p. 540; Migula, Kryptog.-Fl. Deutschl. III, 1, 1910, S. 476; Grove, Brit. Rust Fungi, 1913, p. 345; Trotter Fl. Ital. Crypt. Ured., 1914, p. 409; Klebahn, Kryptogfl. M. Brandb. Va, 1914, S. 779, Fig. O9 (S. 782); Fragoso, Fl. Iber. Ured. II, 1925, p. 210.

Syn.: **Melampsora salis-albae** Kleb., Jahrb. wiss. Bot. XXXV, 1900, S. 679; Fig. IV; Syd., Monogr. Ured. III, 1915, p. 372; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 153.

Caeoma alliorum Link (pr. p.), Spec. II, 7, 1825.

Uredo allii-salicis-albae Arth., Résult. scient. Congr. intern. bot. Vienne 1905, 1906, p. 338.

B i o l. Klebahn, Ztschr. Pflanzenkr. XII, 1902, S. 19; XV, 1905, S. 102; Jahrb. Hamburg. wiss. Anst. XX, 1902, S. 8; Wirtswechs. Rostpilze, 1904, S. 415; Schneider-Oreilli, Centrl. Bacteriol. II. Abt., XXV, 1910, S. 438; Mayor, Bull. Soc. Neuchât. sci. natur. LXI, 1936, p. 116; Bull. Soc. bot. Suisse, 51, 1941, p. 318.

Spermagonia somewhat convex, with flat hymenium, about 120μ high, 210μ wide. Aecia on leaves and stems, in groups on yellowed patches about 1 mm, surrounded by remnants of the torn epidermis, bright orange-yellow. Aeciospores irregular, usually angular, isodiametric, rarely prismatic, $17-26 \times 15-18\mu$; spore wall $1.0-1.5\mu$ thick, verruculose; verrucules up to 1μ wide, at approximately 1μ intervals.

Uredia foliicolous on young shoots emerging from the buds, and on the bark of branches; on the bark usually solitary, projecting from the cracked periderm, up to 5 mm long, or (on Salix alba-vitellina) grouped on large patches, up to 3.5 cm long and 8 mm wide; solitary sori, up to 2 mm wide, are surrounded by the raised epidermis; on young shoots uredia are thickly set, up to 2 mm long; on leaves, uredia are small, round, up to 1 mm, occasionally confluent, in patches 4–5 mm wide, usually hypophyllous, rarely epiphyllous, producing corresponding pale yellow or reddish spots on the upper side of the leaf. Urediospores usually prismatic, frequently thickened at the upper end, and then pyriform or digitate, $20-36 \times 11-17\mu$; spore walls up to 2μ thick, smooth at the apex and sparsely verrucose on the remaining surface (warts at intervals of $2.0-2.5\mu$). Urediospores on samples from different geographical regions show certain deviations from the type; in collections from the vicinity of Frunze (Kirghiz SSR) they are ellipsoid, prismatic, ovoid, angular, rarely globoid, $16.3-32 \times 14-20.3\mu$; from the Gul'cha District (Kirghiz SSR) the urediospores are ellipsoid, globoid, rarely prismatic, $16.3-33 \times 16-22\mu$, yellowish, wall up to 4.1μ thick. Paraphyses capitate with thin pedicels, or digitate, $50-70\mu$ long; heads $15-20\mu$ thick, rarely
355 less than 15μ; pedicels $2.5-5\mu$, up to 10μ thick, their wall up to 3μ; in uredia on the bark no paraphyses were detected (Figure 136).

Telia amphigenous, scattered, more abundantly on the upper side, subepidermal, dark brown. Teliospores irregularly prismatic, rounded at both ends, $25-45 \times 7-10\mu$; spore wall light brown, uniformly thin, about 1μ; pore not evident.

Basidiospores pale.

Heteroecious. Aecia were obtained in cultures on Allium vineale L., A. schoenoprasum L., A. ursinum L., A. porrum L., A. cepa L., and on other species (Klebahn, Schneider-Orelli, Mayor). Uredio- and teliospores on Salix alba L.

G e n e r a l d i s t r i b u t i o n: Europe, Asia.

On Allium ursinum L. — EUROPEAN PART: M. Dnp. (Ternopol' Region).

On Salix alba L. — EUROPEAN PART: L. Don., L. V., Bl. (Melitopol'), Crim. (Simferopol'); E SIBERIA: Ang.-Say. (Minusinsk); CENTRAL ASIA: Syr D. (Osh), Pam.-Al. (Gul'cha), Tien Shan (Frunze).

The fungus may overwinter by the mycelium in the cortex of branches on which uredia appear in the spring; it is probably in this connection that

weak experimental infection of leaves of S. alba were repeatedly reported. The identity of the fungus on leaves and cortex was proved by Klebahn (l. c.).

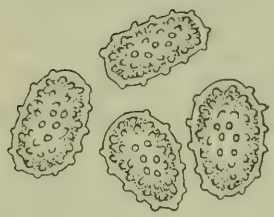


FIGURE 136. Melampsora allii-salicis-albae Kleb. on Salix alba L. Urediospores, × 600. (Orig.)

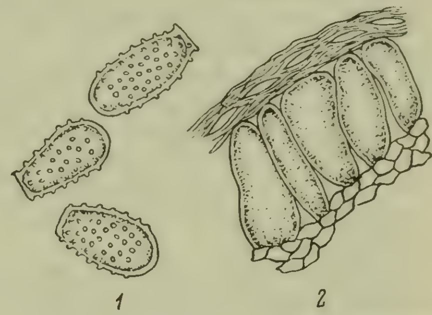


FIGURE 137. Melampsora alii-fragilis Kleb. on Salix fragilis L.:

1 — urediospores; 2 — teliospores; × 600. (Orig.)

16. Melampsora allii-fragilis Kleb., Jahrb. wiss. Bot. XXXV, 1900, S. 671, Fig. III (1—6); Fischer, Ured. Schweiz, 1904, S. 481; Bubák, Rostpilze Böhmens, 1908, S. 195, Fig. 50; Hariot, Uréd., 1908, p. 260; Liro, Ured. Fenn., 1908, p. 540; Migula, Kryptog.-Fl. Deutschl. III, 1, 1910, S. 477, Tab. XIB, Fig. 5, 6; Grove, Brit. Rust Fungi, 1913, p. 344; Klebahn, Kryptogfl. M. Brandb. Va, 1914, S. 781, Fig. O10 (S. 782); Trotter, Fl. Ital. Crypt. Ured., 1914, p. 410, fig. 104; Syd., Monogr. Ured. III, 1915, p. 373; Fragoso, Fl. Iber. Ured. II, 1925, p. 211; Sacc., Sylloge, XXIII, 1925, p. 834; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 155.

Syn.: Caeoma allii-ursini Winter, Pilze Deutschl., 1881, S. 255; Sacc., Sylloge, VII, 1888, p. 868.

Uredo allii-fragilis Arth., Résult. scient. Congr. intern. bot. Vienne, 1905, 1906, p. 338.

Biol. Klebahn, Jahrb. wiss. Bot. XXXV, 1900, S. 671; Ztschr. Pflanzenkr. XII, 1902, S. 18; XV, 1905, S. 103; Jahrb. Hamburg. wiss. Anst. XX, 1903, S. 5; Wirtswechs. Rostpilze, 1904, S. 416; Mayor, Bull. Soc. Neuchât. sci. natur. LXI, 1936, p. 115; Bull. Soc. bot. Suisse, 51, 1941, p. 318.

Spermagonia foliicolous, subepidermal, slightly projecting, flat, pale, about 200 μ wide.

Aecia on leaves and stems, mostly grouped in oblongs along the midrib, 0.5—1.0 mm wide, up to 2 mm long, surrounded by the remnants of the raised epidermis, orange-yellow. Aeciospores irregular, usually angular, isodiametric or prismatic, rarely globoid, $18-25 \times 12-19\,\mu$, walls from
356 1 to 2 μ thick; verrucules flat, about 0.75 μ wide, interspace 1.25 μ.

Uredia hypophyllous, sometimes also epiphyllous, small, about 0.5 mm, round, bordered by the torn epidermis, orange-colored, with corresponding reddish-yellow spots on the upper side of the leaf. Urediospores elongate,

usually slightly broader at the apex, often oblong-obovoid, $22-33 \times 12-13\mu$; wall up to 3μ thick, sometimes with thinner spots, distantly verrucose (interspaces $2-3\mu$), smooth and usually thinner at the apex. Paraphyses $50-70\mu$ long, capitate, on thin pedicels ($3-5\mu$), heads $15-20\mu$, occasionally digitate, with tapering heads ($10-15\mu$) and thickened pedicels (7μ); walls evenly thick, $3-5\mu$.

Telia mostly epiphyllous, less frequently hypophyllous, arising between the cuticle and epidermis, in groups or solitary, scattered frequently over the entire leaf surface, $0.25-1.5\ \mu$ wide, dark brown. Teliospores irregularly prismatic, rounded at both ends, usually more elongate on the upper side of the leaf, $30-48 \times 7-14\mu$; spore wall light brown, about 1μ thick, not thickened at apex; pore not evident (Figure 137). Basidiospores orange-colored.

Heteroecious. Aecia on species of **Allinum**. Uredio- and teliospores on **Salix fragilis** L., **S. pentandra** L., **S. fragilis** × **pentandra**. The fungus is morphologically indistinguishable from **Melampsora galanthi-fragilis** Kleb.

General distribution: Europe.

On **Allium cepa** L. and on **Allium oleraceum** L. — EUROPEAN PART: M.-Dnp. (Kursk Region: Borisov District).

On **Salix fragilis** L. — EUROPEAN PART: U. Dnp. (Smolensk Region), M. Dnp. (Belaya Tserkov; Kursk Region: Borisov District), U. V. (Kaluga), Transv. (Buguruslan), V.-Don (Voronezh, Zadonsk, Tambov), L. Don. (Lebedyan), Bl. (Gornostaevka).

According to Klebahn (l. c.) basidiospores from **Salix fragilis** L. infected **Allium vineale** L., **A. sativum** L., **A. schoenoprasum** L., **A. ascalonicum** L., **A. ursinum** L.; weakly infected **A. porrum** L., failed to infect **A. Moly** L. and **Galanthus nivalis** L. Aeciospores from **Allium vineale** L. and **A. schoenoprasum** infected **Salix fragilis** L., **S. pentandra** L. and **S. fragilis** × **pentandra**; failed to infect **S. alba** L., **S. amygdalina** L., **S. alba** × **amygdalina**, **S. amygdalina** × **viminalis** and **Populus nigra** L. Mayor (l. c.) repeated Klebahn's experiments and obtained infection of 19 species of **Allium** (including **A. moly**) inclusive) by sowing basidiospores from **Salix pentandra**; in the case of reverse infection with aeciospores from 17 species of **Salix**, only **S. pentandra** was infected.

17. **Melampsora galanthi-fragilis** Kleb., Ztschr. Pflanzenkr. XII, 1902, S. 27, Fig. 3; Fischer, Ured. Schweiz, 1904, S. 479; Bubák, Rostpilze Böhmens, 1908, S. 195, Fig. 50; Hariot, Ured., 1908, p. 260; Liro, Ured. Fenn.,
357 1908, p. 541; Migula, Kryptog.-Fl. Deutschl., III, 1, 1910, S. 477; Klebahn, Kryptogfl. M. Brandb. Va, 1914, S. 783, Fig. O11 (S. 782); Trotter, Fl. Ital. Crypt. Ured., 1914, p. 411; Syd., Monogr. Ured. III, 1915, p. 373; Fragoso, Fl. Iber. Ured. II, 1925, p. 213, fig. 101; Sacc., Sylloge, XXIII, 1925, p. 836; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 155.

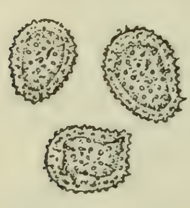


FIGURE 138. Melampsora galanthi-fragilis Kleb. on Galanthus nivalis L. Aeciospores, × 600. (Orig.)

Syn.: **Uredo galanthi** Unger, Exanth. d. Pflanzen, 1833, S. 88.

U. galanthi Kirchner, Lotos, VI, 1856, p. 179.

U. galanthi-fragilis Arth., Résult. scient. Congr. intern. bot. Vienne, 1905, 1906, p. 338.

Caeoma galanthi Schroet., Abhandl. Schles. Ges. vaterl. Kult. 1869/72, 1872, S. 30; Sacc., Sylloge, VII, 1888, p. 866; Schroeter, Pilze Schles. 1889, S. 377.

Caeoma galanthi Winter, Pilze Deutschl., 1881, S. 256.

Biol. Klebahn, Ztschr. Pflanzenkr. XII, 1902, S. 27; Jahrb. Hamburg. wiss. Anst. XX, 1903, S. 5; Wirtswechs. Rostpilze, 1904, S. 417; Schroeter, 71. Jahresber. Schles. Ges. vaterl. Kult., 1893, S. 32.

Spermagonia flat, subepidermal, conoid, $80-100\,\mu$ high, $130-160\,\mu$ wide.

Aecia amphigenous, solitary or in groups on yellowed spots, sometimes arranged in rings around the spermagonia, $1-2$ mm, frequently coalescing in groups surrounded by remnants of the torn epidermis, bright orange-colored. Aeciospores globoid or orbicular-ovoid, usually angular, frequently tetrahedral, $17-22 \times 14-19\,\mu$; wall verrucose, $1-2\,\mu$ thick; verrucae low, $0.75\,\mu$ wide, at intervals of $1.25\,\mu$ (Figure 138).

Uredia hypophyllous, rarely epiphyllous, scattered or in groups, $0.5-1.0$ mm surrounded by remnants of the raised epidermis, circular, bright-yellow, causing the appearance of yellow spots. Urediospores mostly ellipsoid, rarely ovoid, frequently pyriform or digitate, usually widened at the apex, $25-38 \times 12-16\,\mu$; wall sparingly verrucose (interspace $2-3\,\mu$), $3\,\mu$ thick, somewhat thinner and smooth at the apex. Paraphyses $50-70\,\mu$ long, for the most part capitate; head $17-23\,\mu$ thick.

Telia mainly epiphyllous, rarely hypophyllous, solitary or in groups arising, as in M. allii-fragilis, between the cuticle and epidermis, $0.25-1.0$ mm, dark brown. Teliospores irregularly prismatic, more or less rounded at both ends, $25-45 \times 8-15\,\mu$; walls pale brownish, thin, about $1\,\mu$, not thickened at the apex; pore inconspicuous.

Heteroecious. Aecia on Galanthus nivalis L. Uredio- and teliospores on Salix fragilis L., S. pentandra L. and S. fragilis × pentandra. Morphologically the fungus is very close to M. allii-fragilis Kleb.

General distribution: Europe.

On Galanthus nivalis L. — EUROPEAN PART: M. Dnp. (Kamenets-
358 Podol'skii, Khmel'nitskii, Ternopol' Region), U. Dns. (Ternopol' Region).

On Galanthus plicatus M. B. — EUROPEAN PART: Crim. (the Alma Valley in the Crimean Nature Reserve).

On Salix fragilis L. — EUROPEAN PART: Bl. (Melitopol'), Balt. (?).

Klebahn reported only one instance of infection of Galanthus nivalis L. and Allium vineale L. with basidiospores from Salix fragilis; in all other experiments Allium vineale was infected but not Galanthum nivalis, nor Larix decidua. Infection of Galanthus and Allium species with basidiospores from Salix fragilis is explained by Klebahn by the presence of teliospores of both M. allii-fragilis and M. galanthi-fragilis on the leaves of S. fragilis. According to Klebahn aeciospores from Galanthus nivalis infect S. fragilis, but do not infect S. amygdalina L. or S. amygdalina × viminalis. Urediospores from S. fragilis infect S. pentandra and S. fragilis × pentandra; do not infect S. amygdalina L., S. alba × fragilis, or S. amygdalina × viminalis.

18. Melampsora amygdalinae Kleb., Jahrb. wiss. Bot. XXXIV, 1900, S. 352, Fig. (S. 355); Fischer, Ured. Schweiz, 1904, S. 478; Sacc., Sylloge, XVII, 1905, p. 463; XXIII, 1925, p. 835; Bubák, Rostpilze Böhmens, 1908, S. 193, Fig. 49; Hariot, Uréd., 1908, p. 260; Liro, Ured. Fenn., 1908, p. 537; Migula, Kryptog.-Fl. Deutschl. III, 1, 1910, S. 475, Taf. XI, Fig. 1, 2; Trotter, Fl. Ital. Crypt. Ured., 1914, p. 408, fig. 103; Klebahn, Kryptogfl. M. Brandb.

Va, 1914, S. 776, Fig. O7 (S. 782); Syd., Monogr. Ured. III, 1915, p. 369; Fragoso, Fl. Iber. Ured. II, 1925, p. 208; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 154.

Syn.: Uredo amygdalina Arth., Résult. scient. Congr. intern. bot. Vienne 1905, 1906, p. 338.

Biol. Klebahn, Jahrb. wiss. Bot. XXXIV, 1900, S. 352; Jahrb. Hamburg. Anst. XX, 1902, S. 4; Wirtswechs. Rostpilze, 1904, S. 413.

Spermagonia amphigenous, subepidermal, with slightly flexed hymenium, about 100 μ wide, 50 μ high.

Aecia on young leaves, usually hypophyllous, also on young branches, up to 1 mm, mostly in groups; on branches up to 1 cm long, on leaves 3—6 mm, more or less confluent, bright orange-colored. Aeciospores globoid or ovoid, slightly angular, 18—23 × 14—19 μ, catenate, with small intermediate cells; wall 2 μ thick, with a ridged structure above; ridges very short, up to 0.75 μ thick, at approximately 1 μ intervals.

Uredia hypophyllous, scattered, small, circular, 0.5 mm, bright orange-colored, producing yellowish spots on the corresponding upper side of the leaf. Urediospores ovoid, prismatic-ovoid or digitate, 19—32 × 11—15 μ; wall up to 2 μ thick, distantly verrucose (at 2 μ intervals), smooth at the upper end. Paraphyses capitate or digitate, 30—50 μ long, heads 10—18 μ wide, pedicels 4—10 μ; wall usually thin, rarely up to 3 μ thick.

Telia hypophyllous, subepidermal, small, about 0.5 mm, when mature dark brown tinged with violet, gregarious, covering the leaf areas in between the veins. Teliospores prismatic, frequently irregular, rounded at both ends, 18—42 × 7—14 μ; spore wall light brown, uniformly thick, about 1 μ; pore not evident (Figure 139).

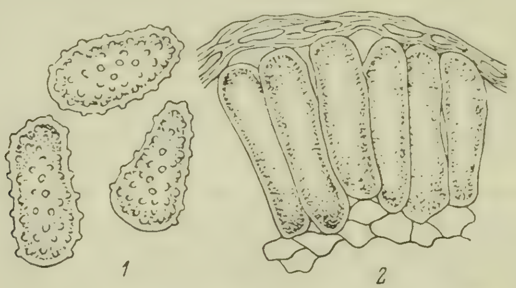


FIGURE 139. **Melampsora amygdalinae** Kleb. on **Salix amygdalina** L.:

1 — urediospores; 2 — teliospores; ×600. (Orig.)

The sole macrocyclic monoecious species of Melampsora on Salicaceae; 0, I, II and III on Salix amygdalina L. (= S. triandra L.). Urediospores are shorter than those of M. larici-pentandrae, the spore wall thinner and the
359 sculpture more delicate.

General distribution: Europe, Asia (USSR).

On Salix amygdalina L. — EUROPEAN PART: Dv.-Pech., Lad.-Ilm., U. V., V.-Kama (Kuibyshev and Molotov regions, Udmurt ASSR), Transv. (Tatar ASSR), V.-Don (Tambov, Kuibyshev, and Kharkov regions), L. Don. (Saratov and Rostov regions), M. Dnp. (Kursk and Vinnitsa regions), U. Dnp. (Chernigov Region), Bl. (Nikolaev Region); W SIBERIA: Irt. (Akmolinsk District); FAR EAST: Uss. (Voroshilov); CENTRAL ASIA: Pam.-Al.

In cultures the fungus proved infective for **Salix pentandra** L.; and not infective for S. fragilis L., S. alba L., S. alba × amygdalina, S. cinerea L., S. caprea L., S. mollissima Ehrh. (?). Basidiospores from S. amygdalina sown on species of Galanthus, Allium, Ribes and Larix failed to induce infection while in the same experiment spermagonia formation was recorded on S. amygdalina and S. pentandra (Klebahn, l. c.).

On Populus

19. **Melampsora microspora** Tranz. et Eremeeva, Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 155.

Spermagonia and aecia unknown.

Uredia mostly hypophyllous, occasionally also on the upper side, scattered, small, frequently confluent, yellow, causing the appearance of yellow angular spots on the upper side of the leaf. Urediospores globoid or broad-ellipsoid, $11-17 \times 11-13\,\mu$; wall uniformly thick, up to $4\,\mu$, colorless, faintly verrucose, almost smooth. Paraphyses $30-60\,\mu$ long, clavate, often capitate, broadened in places up to $16\,\mu$; wall $5\,\mu$ thick.

Telia mostly hypophyllous, subepidermal, coalescing in crusts, scattered over the entire frond, rusty, at length chestnut-brown, causing corresponding gray-brown patches on the upper side of the leaves. Teliospores $30-68 \times 10-13\,\mu$, prismatic, not thickened at apex (Figure 140).

Uredio- and teliospores on Populus nigra L. and P. usbekistanica Kom.

On Populus nigra L. — CENTRAL ASIA: Syr D. (Ul'terma village, Isfara, Tashkent (also in Iran: Zurabad)).

On Populus usbekistanica Kom. — CENTRAL ASIA: Pam.-Al. (Varzob).

On Populus sp. — CENTRAL ASIA: Syr. D.

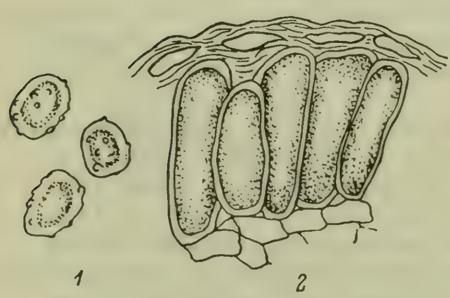


FIGURE 140. **Melampsora microspora** Tranz. on **Populus usbekistanica** Kom.:

1 — urediospores; 2 — teliospores; ×600. (Orig.)

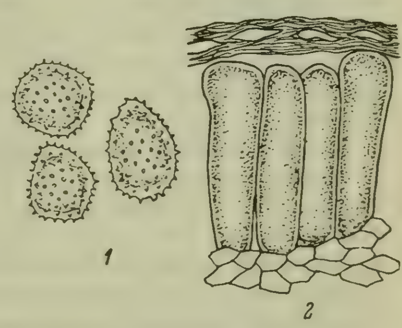


FIGURE 141. **Melampsora rostrupii** Wagn. on **Populus tremula** L.:

1 — urediospores; 2 — teliospores; × 600. (Orig.)

20. **Melampsora rostrupii** Wagner, Österr. bot. Ztschr. LVI,
360 1896, S. 273; Sacc., Sylloge, XVII, 1905, p. 463; Fischer, Ured. Schweiz, 1904, S. 501; Bubák, Rostpilze Böhmens, 1908, S. 204, Fig. 56; Hariot, Uréd., 1908, p. 263; Liro, Ured. Fenn., 1908, p. 534; Migula, Kryptog.-Fl. Deutschl. III, 1, 1910, S. 483; Grove, Brit. Rust Fungi, 1913, p. 351, 352, fig. 263; Trotter, Fl. Ital. Crypt. Ured., 1914, p. 406; Klebahn, Kryptogfl. M. Brandb. Va, 1914, S. 772, Fig. O5 (S. 766); Syd., Monogr. Ured. III, 1915, p. 343; Fragoso, Fl. Iber. Ured. II, 1925, p. 203; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 156.

Syn.: Caeoma mercurialis Link, Spec. plant. VI, II, 1825, p. 35; Sacc., Sylloge, VII, 1888, p. 868.

Uredo mercurialis Mart., Prodr. fl. Mosq. II, 1817, p. 229.

Uredo confluens var. mercurialis-perennis Pers., Syn. fung., 1801, p. 214.

Melampsora aecidioides (DC) Schroet., Pilze Schles., 1889, S. 362, pr. p.; Sacc., Sylloge, VII, 1888, S. 590, pr. p.

Biol. Rostrup, Overs. Vid. Selsk. Forh., 1884, p. 14; Plowright, Mon. Ured. Brit., 1889, p. 241; Wagner, Österr. bot. Ztschr. LVI, 1896, S. 273; Klebahn, Ztschr. Pflanzenkr. VII, 1897, S. 336, Fig. (S. 340); IX, 1899, S. 144; Jahrb. wiss. Bot. XXXIV, 1900, S. 349; Wirtswechs. Rostpilze, 1904, S. 407; Jacky, Ber. Schweiz. bot. Ges., IX, 1899, S. 22.

Spermagonia subepidermal with flat or somewhat flexed hymenium and sterigmata convergent in the shape of a truncate cone, $110-190\mu$ wide, $45-70\mu$ high.

Aecia hypophyllous, rarely on stems, in tightly crowded round or irregular groups measuring 5 — 7 mm, on yellowed patches, bright orange-colored. Aeciospores ovoid, blunt-angular, $13-20 \times 12-16\mu$; wall colorless, verrucose; warts low, flat, about 1μ wide, $1.0-1.5\ \mu$ apart.

Uredia hypophyllous, up to 1 mm, compact, causing the appearance of large yellow patches on the corresponding upper sides of the leaves. Urediospores mostly ovoid, globoid, or somewhat angular, $15-28 \times 14-18\mu$; wall colorless, up to 3μ thick, distantly verrucose $(2-3\mu)$. Paraphyses about 50μ long, mostly capitate, rarely digitate, at the apex $15-23\mu$ wide; wall $3-6\mu$ thick.

Telia hypophyllous, subepidermal, dark brown, small, about 1 mm.
361 Teliospores prismatic, more or less rounded at both ends, $27-44 \times 6-11\mu$ (according to Klebahn, $25-40 \times 5-9\mu$); wall thin, 1μ, pale yellowish without apical thickening; pore imperceptible (Figure 141).

Heteroecious. Aecia on Mercurialis perennis; uredio- and teliospores on **P. tremula** L. and **P. alba** L. In cultures it is passed onto **Populus** nigra L., **P.** canadensis Moench., **P.** balsamifera L. and **P.** italica (Dur.) Moench.

To this species should probably be referred Caeoma pulcherrimum Bubák (= Melampsora pulcherrima (Bub.) Maire in Sydow, Monogr. Ured., IV, 1924, p. 378; Fragoso, Fl. Iber. Ured., II, 1925, p. 204, 383, fig. 99, 100; Hariot, Uréd., 1908, p. 263; Trotter, Fl. Ital. Crypt. Ured., 1914, p. 447); aecia on Mercurialis annua, uredio- and teliospores on Populus alba in Algeria and in the Mediterranean area as far as Dalmatia. Aecia on stems, usually coalescing in linear groups, 2 — 10 cm long; seldom on leaves. Aeciospores usually globoid to ellipsoid, $16-26 \times 14-21\mu$; spore wall yellowish when mature. Uredio- and teliospores indistinguishable from those of Melampsora rostrupii.

General distribution: Europe.

On Mercurialis perennis L. — EUROPEAN PART: Lad.-Ilm., U. V., V.-Don., V.-Kama, M. Dnp., Crim., Balt., U. Dns.

On Populus tremula L. — EUROPEAN PART: Lad.-Ilm.

The connection of aecia on Mercurialis perennis with II and III on **Populus tremula** was first established by Rostrup and later confirmed by Plowright, Wagner, Klebahn, and Jacky.

21. Melampsora pruinosae Tranz., Tranzschel et Serebriannikov, Mycotheca rossica, No. 265, 1912; Syd., Monogr. Ured. III, 1915, p. 345; Sacc., Sylloge, XXIII, 1925, p. 840; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 155.

Spermagonia and aecia unknown.

Uredia amphigenous, on small dark patches, scattered over the entire frond, pale orange-colored, minute, in groups, rarely solitary. Urediospores globoid, ovoid or ellipsoid, coarsely verrucose, $20-28 \times 16-18\mu$; wall evenly thick, $3-4\mu$. Paraphyses capitate or clavate, colorless, $45-60\mu$ long, head-width $16-20\mu$; wall uniformly thick, $1.5-4.0\mu$ (Figure 142).

Telia amphigenous, subepidermal, usually small, reddish-brown. Teliospores prismatic, pale yellowish, $40-50 \times 10-13\mu$, not thickened at apex.

Uredio- and teliospores on Populus pruinosa Schrenk and P. euphratica Oliv.

General distribution: Europe, Asia (Central Asia).

On **Populus pruinosa** Schrenk — EUROPEAN PART: L. V.; CENTRAL ASIA: Syr D. (Tashkent), Kara K., Amu D. piedmonts (Farab).

On (?) **Populus** euphratica Oliv. — CENTRAL ASIA: Kara K.

On **Populus** sp. — CENTRAL ASIA: Kara K. (Murgab Valley).

The species is close to the type species of Melampsora tremulae and distinguished from it by the thick-walled urediospores. This feature is
362 apparently connected with the drier climate at the site of origin, for on **Populus alba**, in Central Asia, urediospores are also thicker-walled than in Europe (annotation by V. G. Tranzschel).

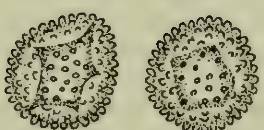


FIGURE 142. **Melampsora pruinosae** Tranz. on **Populus pruinosa** Schrenk. Teliospores, × 600. (Orig.)

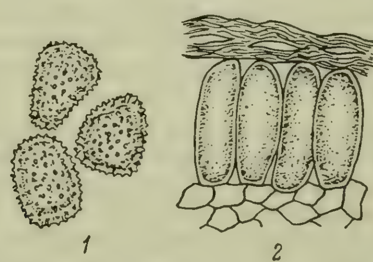


FIGURE 143. **Melampsora magnusiana** Wagn.:

1 — aeciospores on **Chelidonium majus** L.;
2 — teliospores on **Populus tremula** L.;
× 600. (Orig.)

22. Melampsora magnusiana Wagn., Österr. bot. Ztschr. XLVI, 1896, S. 273; Fischer, Ured. Schweiz, 1904, S. 500; Sacc., Sylloge, XVII, 1905, S. 463; Bubák, Rostpilze Böhmens, 1908, p. 204, fig. 55; Hariot, Uréd., 1908, p. 263; Liro, Ured. Fenn., 1908, p. 533; Migula, Kryptog.-Fl. Deutschl. III, 1, 1910, S. 483; Grove, Brit. Rust Fungi, 1913, p. 350, 353; Trotter, Fl. Ital. Crypt. Ured., 1914, p. 405; Klebahn, Kryptogfl. M. Brandb. Va, 1914, S. 773, Fig. O6 (S. 766); Syd., Monogr. Ured. III, 1915, p. 341; Fragoso, Fl. Iber. Ured. II, 1925, p. 203; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 156.

Syn.: Caeoma chelidonii Magn., Hedwigia, XIV, 1875, S. 20.

? Aecidium chelidonii Dietr., Arch. Naturk. Liv.-, Esth- u. Kurlands, 2, 1, 1859, S. 494.

Caeoma fumariae Link, Spec. plant. VI, II, 1825, p. 24.

Uredo Magnusiana Arth., Résult. scient. Congr. intern. bot. Vienne 1905, 1906, p. 338.

Melampsora Klebahni Bubák, Ztschr. Pflanzenkr. IX, 1899, S. 26; Klebahn, Wirtswechs. Rostpilze, 1904, S. 409.

Biol. Sydow, Ber. Deutsch. bot. Ges. XI, 1893, S. 232; Magnus, Ber. Deutsch. bot. Ges. XI, 1893, S. 49; Klebahn, Ztschr. Pflanzenkr. VII, 1897, S. 335, Fig. 3b (S. 340); IX, 1899, S. 144; XII, 1902, S. 43; XV, 1905, S. 101; Jahrb. wiss. Bot. XXXIV, 1900, S. 349; XXXV, 1901, S. 690; Jahrb. Hamburg. wiss. Anst. XX, 1902, S. 18; Wirtswechs. Rostpilze, 1904, S. 408, 409; Bubák, Ztschr. Pflanzenkr. IX, 1899, S. 26; Hiratsuka, Japan. Journ. Botany, VI, 1, 1932, p. 15.

Spermagonia epiphyllous, subepidermal, with flat hymenium, and sterigmata converging in the shape of a truncate cone, $130-150\mu$ wide, $30-40\mu$ high.

Aecia on yellowish spots on the underside of leaves, in crowded round groups, often confluent, 1 – 2 mm, rarely 5 mm, bright orange-colored. Aeciospores globoid-angular or ovoid, $17-22 \times 12-16\mu$; wall $1.0-1.5\mu$ thick, verruculose; verrucules flat, up to 0.75μ wide, at approximately 1μ intervals.

Uredia hypophyllous, small, about 0.5 mm, rarely up to 1.0 mm, occasionally coalescing up to 3 mm; cause corresponding faint, dark patches on the upper side of leaves. Urediospores ovoid, globoid or elongate, rarely angular, $17-26 \times 13-24\mu$ (according to Klebahn, $17-24 \times 12-18\mu$); wall colorless, up to 3μ thick, sparsely verrucose (distanced $2-3\mu$ apart). Paraphyses $40-50$ up to 80μ long, capitate, rarely digitate; head-width $14-24\mu$; wall $3-5\mu$ at the apex up to $6-7\mu$ thick.

Telia hypophyllous, subepidermal, dark brown, small, measuring about 1 mm. Teliospores prismatic, rounded at both ends, $40-50 \times 7-10\mu$; pore apical, scarcely noticeable, conspicuous in germinating spores (Figure 143).

Heteroecious. Aecia on **Chelidonium majus** L. and on species of **Corydalis**. Uredio- and teliospores on **Populus tremula** L., in Japan on **P. sieboldii** Miq. (according to Hiratsuka); passes readily onto **Populus alba** L. and **P. canescens** Sm. (**alba × tremula**).

363 General distribution: Europe, Asia.

On **Chelidonium majus** L. — EUROPEAN PART: Lad.-Ilm., V.-Don, L. Don (Saratov), Balt.

On Corydalis bracteata L. — W SIBERIA: Ob (Tomsk).

On Corydalis solida Sw. — EUROPEAN PART: Lad.-Ilm., V.-Don, M. Dnp., L. Don, V. Kama; FAR EAST: Uss.

On Corydalis cava Sch. et K. — EUROPEAN PART: M. Dnp.

On Corydalis remota Fisch. — FAR EAST: Uss. (Voroshilov).

On Corydalis nobilis Pers. — W SIBERIA: Irt. (Semipalatinsk).

On Corydalis ambigua Ch. et Schl. — FAR EAST: Uss. (Voroshilov) (uredio- and teliospores on Populus tremula L.).

The connection of the aecia on Chelidonium majus with the uredio- and teliospores on Populus tremula was established by Magnus and Sydow. The connection of the aecia on Corydalis with the uredio- and teliospores on Populus tremula was established by Bubák (Melampsora klebahnii Bubák). According to Klebahn, cultures of the fungus are readily passed onto Populus alba, and very weakly onto P. nigra, P. canadensis, P. balsamifera, and P. pyramidalis. The biological identity of the aecia on Chelidonium and Corydalis was experimentally established by Klebahn (l. c., 1905).

23. Melampsora larici-tremulae Kleb., Ztschr. Pflanzenkr. IX, 1899, S. 146; Fischer, Ured. Schweiz, 1904, S. 498, Fig. 315; Sacc., Sylloge, XVII, 1905, p. 463; Hariot, Uréd., 1908, p. 263; Liro, Ured. Fenn., 1908, p. 535; Grove, Brit. Rust Fungi, 1913, p. 349; Klebahn, Kryptogfl. M. Brandb. Va, 1914, S. 767, 901, Fig. O3 (S. 766); Trotter, Fl. Ital. Crypt. Ured., 1914, p. 403.

Syn.: Melampsora laricis Hartig, Allg. Forst-u. Jagdztg., 1885, S. 326; Bubák, Rostpilze Böhmens, 1908, S. 202; Migula, Kryptog.-Fl. Deutschl. III, 1, 1910, S. 482; Syd., Monogr. Ured. III, 1915, p. 339; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 155.

Uredo laricis Arth., Résult. scient. Congr. intern. bot. Vienne 1905, 1906, p. 338.

Caeoma laricis Hartig, Wichtige Krankh. d. Waldbäume, 1874, S. 93, pr. p.

Biol. Hartig, Allg. Forst- u. Jagdztg., 1885, S. 326; Bot. Centrbl., 1885, S. 24; Klebahn, l. c.; Ztschr. Pflanzenkr. IV, 1894, S. 12; VII, 1897, S. 341, Fig. 2a, b (S. 340); XII, 1902, S. 41; XVII, 1907, S. 154; XXII, 1912, S. 342, Fig. (S. 343); Jahrb. wiss. Bot. XXXIV, 1900, S. 349; XXXV, 1901, S. 689; Jahrb. Hamburg. wiss. Anst. XX, 1902, S. 18; Wirtswechs. Rostpilze, 1904, S. 405; Fischer, Entwicklungsgesch. Untersuch. über Rostpilze, 1898, S. 90; Liro, Acta Soc. fauna et flora Fenn., XXIX, 6, 1906, p. 1; 7, 1907, p. 54; Dietel, Centrbl. Bakteriol. II. Abt., XXXI, 1911, S. 95; Dmitriev. Bot. muz. Akad. Nauk, XII, 1914, p. 126—128.

Spermagonia blunt-conoid, under the ruptured epidermis, sometimes covered by the cuticle, up to 95μ wide, 50μ high.

364 Aecia solitary, scanty, on yellowed patches, small, up to 1 mm, pale orange-colored. Aeciospores globoid, ovoid, or somewhat angular, 14—17 × 12—16μ; spore wall about 1μ thick, outer layer with a ridged structure; ridges short, 0.5μ thick, at approximately 1μ intervals.

Uredia hypophyllous, (according to Schroeter on branches), about 0.5 mm loose, causing the appearance of small yellowish spots on the corresponding upper side of the leaves. Urediospores oval or oblong in section, obovoid, rarely globoid, 15—22 × 10—15μ; spore wall about 2μ thick, sparsely verrucose (warts approximately 2μ apart). Paraphyses evenly distributed

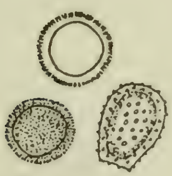
over the entire sorus, 40–45 μ long, mostly with elongate (rarely with round) heads, 8–17 μ wide, tapering into pedicels; wall 3.5 μ thick (Figure 144).

Telia hypophyllous, dark brown, subepidermal, small, up to 1 mm, solitary or in groups, scattered over the entire frond. Teliospores prismatic, rounded at both ends, $40-60 \times 7-12\,\mu$; spore wall thin, $1-2\,\mu$, thickened at apex; apical pore scarcely perceptible. Distinguished from M. larici-populina by the development of telia on the underside of leaves and the absence of apical thickening of the spore wall.

Heteroecious. Aecia on **Larix decidua** Mill.; uredio- and teliospores on Populus tremula L. and P. alba L. Cultures of the fungus cause weak infection of P. balsamifera. The fungus overwinters apparently by mycelium in fall buds, which are found heavily infected in the spring, the very young ones not even unfolding the leaves (Dmitriev, 1914, p. 126; Klebahn, 1912, p. 343, Fig.).

General distribution: Europe, Asia (Siberia) (see **Melampsora tremulae** Tul., **Caeoma laricis** Hartig).

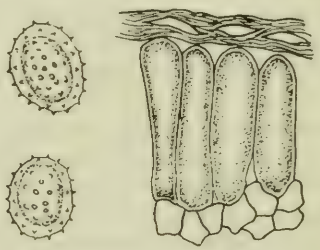
Connection between the aecia on Larix decidua Mill. and uredio- and teliospores on Populus tremula was established by Hartig (l. c.). Aecia obtained on Larix decidua from basidiospores collected from Populus tremula infected both P. tremula and P. alba, and very faintly P. balsamifera. In cultures, basidiospores yielded from a single leaf sometimes infect simultaneously Larix and Mercurialis, or Larix and Chelidonium, or even Larix, Mercurialis, and Chelidonium; this shows either coincidental occurrence on the leaves of teliospores of Melampsora larici-tremulae, M. rostrupii, and M. magnusiana, or the weak specialization of the parasite.



1 2

FIGURE 144. **Melampsora larici-tremulae** Kleb.:

1 — aeciospores;
2 — urediospores.
(After Klebahn)



1 2

FIGURE 145a. **Melampsora pinitorqua** (A. Br.) Rostr.:

1 — urediospores; 2 — teliospores on **Populus tremula** L.; × 600.

24. **Melampsora pinitorqua** (A. Br.) Rostr., Overs. Vid. Selsk. Forh., 1884, p. 14 –16; Fischer, Ured. Schweiz, 1904, S. 499; Sacc., Sylloge, XVII, 1905, p. 463; Bubák, Rostpilze Böhmens, 1908, S. 202, Fig. 53, 54 (S. 203); Hariot, Ured., 1908, p. 263; Liro, Ured. Fenn., 1908, p. 531; Grove, Brit. Rust Fungi, 1913, p. 350, fig. 262 (p. 351); Trotter, Fl. Ital. Crypt. Ured., 1914, p. 404, fig. 102; Migula, Kryptog.-Fl. Deutschl. III, 1, 1910, S. 482, Taf. XI, Fig. 5; Klebahn, Kryptogfl. M. Brandb. Va, 1914, S. 770, Fig. O4 (S. 766); Syd., Monogr. Ured. III, 1915, p. 340; Fragoso, Fl. Iber. Ured. II, 1925, p. 201, fig. 98; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 156.

Syn.: **Caeoma pinitorquum** A. Br. apud de Bary, Monatsber. Berl. Akad., 1864, S. 624; Sacc., Sylloge, VII, 1888, S. 867.

Uredo pinitorqua Arth., Résult. scient. Congr. intern. bot., Vienne 1905, 1906, p. 338.

Biol. Rostrup, Tidsskr. for Skovbrug, VI, 1883, p. 219; Overs. Vid. Selsk. Forh., 1884, p. 14; Hartig, Allg. Forst- u. Jagdztg., 1885, S. 326; Bot. Centrbl. XXIII, 1885, S. 362; Klebahn, Ztschr. Pflanzenkr. XII, 1902, S. 39, Fig. 4 (S. 40); XVII, 1907, S. 154; Jahrb. Hamburg. wiss. Anst. XX, 1902, S. 17; Wirtswechs. Rostpilze, 1904, S. 403; Vanin, Lesn. fitopatol., 1948, p. 119—121.

365 Spermagonia on cortex of young shoots, subcuticular, or intraepidermal on yellow patches, give rise to truncate-conoid tubercles.

Aecia on young shoots erumpent from under cortex, also on stems and needles of seedlings, mainly solitary, lineate, varying in size, up to 2 cm long and 3 mm wide; on needles small, 1—2 mm long, reddish-orange. Aeciospores mainly globoid or ovoid, $14-20 \times 13-17\,\mu$, rarely oblong in section, $22 \times 10\,\mu$; wall evenly thickened, about $2\,\mu$, or with thickenings up to $4\,\mu$, verruculose; warts in the form of very short ridges, less than $0.5\,\mu$ thick, at approximately $0.75\,\mu$ intervals.

FIGURE 145b. Melampsora pinitorqua (A. Br.) Rostr. Pineshoot and seedling damaged by the fungus. (Orig.)

Uredia hypophyllous, solitary or in groups, spread over the entire frond, small, about 0.5 mm, causing the appearance of yellow spots on the corresponding upper side of the leaf. Urediospores mostly ovoid, often slightly tapering at one end, rarely globoid or ellipsoid, $15-22 \times 11-16\,\mu$ (according to Rostrup, $22-27 \times 12-19\,\mu$); wall usually with thickenings up to $5-6\,\mu$ at both ends of the spores arranged in rows along their tapered ends, sometimes uniformly thick ($2\,\mu$), sparingly verrucose (at $2-3\,\mu$ intervals). Paraphyses uniformly spread over the sori, $40-50\,\mu$ long, capitate, heads $12-17\,\mu$ wide, $20-25\,\mu$ high, tapering into the thin ($3-4\,\mu$) pedicels; wall $3-7\,\mu$ thick.

Telia hypophyllous, subepidermal, small, about 0.5 mm, brown, usually in groups. Teliospores irregular, prismatic, more or less rounded at both ends, $20-35 \times 7-11\,\mu$ (according to Rostrup, $42-44 \times 12\,\mu$); wall thin, about $1\,\mu$, faintly brownish, not thickened at apex; pore imperceptible (Figure 145a).

Heteroecious. Aecia on Pinus silvestris L.

Aecial mycelium develops in the cortical parenchyme of young shoots, where it apparently overwinters. The infected seedlings and thin shoots soon perish; thicker shoots become twisted owing to the uneven growth, often acquiring the characteristic S-shape. In years of extensive outbreaks pine plantations are severely damaged. Uredio- and teliospores on Populus tremula L., P. alba L., and P. alba × tremula (Figure 145 b).

General distribution: Europe (including the Caucasus).

On Pinus silvestris L. — EUROPEAN PART: Lad.-Ilm., Kar.-Lap., U. V., V.-Kama, V.-Don, Transv., L. Don, U. Dnp., M. Dnp., Balt.; CAUCASUS: W Transc.

On Populus tremula L. — EUROPEAN PART: Lad.-Ilm. (Bologo (experimental infection)); CAUCASUS: Georgian SSR (Sagveri (concomitantly with Caeoma).

366 The genetic links between the different sporophore forms of the fungus have been established by Rostrup. According to Klebahn Populus balsamifera, P. nigra, P. italica, and P. canadensis are not susceptible to cultures of the fungus. Simultaneous infections of Pinus silvestris and Larix decidua were observed by Hartig and Klebahn in experimental sowings of basidiospores from Populus tremula. These authors assumed that the infections were caused by a mixture of Melampsora pinitorqua and M. larici-tremulae present on the poplar leaves.

According to Vanin the fungus is often encountered in pine plantations, especially in young pine cultures, damaging in some years 50—80% of the stands. The control measure suggested by the author consists in collecting and burning all pine needles shed in nurseries and young plantations. The "isolation" distance between poplar and pine stands is important, and should be not less than 250 m. For nurseries Vanin recommends preventive spraying with Bordeaux solution (0.5—1%).

25. Melampsora larici-populina Kleb., Ztschr. Pflanzenkr. XII, 1902, S. 43; Fischer, Ured. Schweiz, 1904, S. 502, Fig. 316; Sacc., Sylloge, XVII, 1905, p. 463; Bubák, Rostpilze Böhmens, 1908, S. 205, Fig. 57; Hariot, Uréd., 1908, p. 264; Liro, Ured. Fenn., 1908, p. 528; Migula, Kryptog.-Fl. Deutschl. III, 1, 1910, S. 484, Taf. XI, Fig. 6—8; Grove, Brit. Rust Fungi, 1913, S. 348, Fig. 261; Trotter, Fl. Ital. Crypt. Ured., 1914, p. 401, fig. 101; Klebahn, Kryptogfl. M. Brandb. Va, 1914, S. 762, Fig. O1 (S. 766); Syd.
367 Monogr. Ured. III, 1915, S. 346, Taf. XIV, Fig. 114; Fragoso, Fl. Iber. Ured. II, 1925, p. 196, fig. 95, 96; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 155.

Syn.: Melampsora populina auct. pr. p.

Uredo larici-populina Arth., Résult. scient. Congr. intern. bot. Vienne 1905, 1906, p. 338.

Caeoma laricis (West.) Hartig, Wichtige Krankh. d. Waldbäume, 1874, S. 93.

Biol. Hartig, Bot. Centrbl. XL, 1889, S. 310; XLVI, 1901, S. 18 (sub M. laricis); Fischer, Entwicklungsgesch. Untersuch. über Rostpilze, 1898, S. 89 (sub M. laricis); Jacky, Ber. Schweiz. bot. Ges. IX, 1899, S. 25; Klebahn, l. c.; Jahrb. wiss. Bot. XXXIV, 1900, S. 352; XXXV, 1900, S. 691 (sub M. populina); Wirtswechs. Rostpilze, 1904, S. 410; Hiratsuka, Japan. Journ. Botany, VI, 1, 1932, p. 13.

Spermagonia 95 μ wide, to 50 μ high.

Aecia hypophyllous, on yellowish patches, 0.25 — 0.5 mm wide, 0.25 — 1.0 mm long, surrounded by the raised epidermis, bright orange-colored. Aeciospores ovoid or globoid, $17-22 \times 14-18\,\mu$; wall $1.5-2.0\,\mu$ thick, colorless, with ridged structures at the apex; the ridges short, about $0.5\,\mu$ thick, at approximately $1\,\mu$ intervals.

Uredia hypophyllous, rarely solitary and epiphyllous, small, up to 1 mm, surrounded by the ruptured epidermis; densely crowded in small groups, causing the appearance of yellow spots on the corresponding upper side of the leaf. Urediospores elongate, $30-40 \times 13-17\,\mu$; wall about $2\,\mu$ thick, reaching at the equator a thickening of $5-6\,\mu$, on account of which the spore cavity appears as if constricted in the middle; distantly verrucose (outerspaces $2.0-2.5\,\mu$), except at the smooth apex. Paraphyses $40-70\,\mu$ long, digitate or capitate, head-width $14-18\,\mu$, pedicels $4-6\,\mu$ thick; wall at the apical portion of heads thickened up to $10\,\mu$.

Telia epiphyllous, subepidermal, forming a conspicuously projecting crust, light brown, later black-brown, small, rarely 1 mm, single or coalescing in groups, often spreading over the entire leaf. Teliospores prismatic, $40-50\,\mu$ (according to Fischer, up to $70\,\mu$) $\times\, 7-10\,\mu$; wall thin, about $1\,\mu$, thickened at the upper end to $2.5-3.0\,\mu$, brownish, almost colorless; pore not evident (Figure 146).

Heteroecious. Aecia on **Larix decidua** Mill.; uredio- and teliospores on **Populus nigra** L., **P. canadensis** Moench., **P. pyramidalis** Roz., **P. laurifolia** Ldb. and **P. suaveolens** Fisch. Distinguished from **Melampsora allii-populina** Kleb. by the epiphyllous development of telia and the ridged structures on the aeciospore walls.

General distribution: Europe (including the Caucasus), Asia (Siberia).

368 On **Larix** — see **Caeoma laricis** (West.) Hartig.

On **Populus nigra** L. — EUROPEAN PART: U. V. (Kasimov, Kostroma), V.-Kama, V.-Don, Transv. (Buzuluk), L. Don (Novokhopersk), U. Dnp. (Kiev, Oster, Chernigov), M. Dnp. (Poltava, Kursk), Balt.; CAUCASUS: Cisc. (Ordzhoni Ridge); W SIBERIA: Irt. (Omsk); E SIBERIA: Ang.-Say. (Minusinsk).

On **Populus pyramidalis** Roz. — EUROPEAN PART: L. Don (Lebedyan), M. Dnp.

On **Populus laurifolia** Ldb. — EUROPEAN PART: Lad.-Ilm. (Leningrad); E SIBERIA: Ang.-Say. (Minusinsk, Uryankhai [Tuva Autonomous Region]).

On **Populus suaveolens** Fisch. — E SIBERIA: Ang -Say. (Minusinsk); FAR EAST: Uss. (Okeanskaya, Maikhe River, Novokievskoe (in a garden with **Larix**)).

On **Populus balsamifera** L. — EUROPEAN PART: Balt., Lad.-Ilm., Dv.-Pech., M. Dnp., V.-Don, V.-Kama (Kirov.).

On **P. canadensis** Moench. (= **Populus deltoides** Marsh.) — EUROPEAN PART: M. Dnp. (Kursk Region: the "Les na Vorskle" ["Forest on the Vorskla River"] Nature Reserve).

On **Populus angulata** Ait. — EUROPEAN PART: V.-Kama (Kirov).

On **Populus candicans** Ait. — EUROPEAN PART: Balt. (Riga).

On **Populus maximowiczii** A. Henry — FAR EAST: Sakh. (S Sakhalin).

On **Populus** sp. cult. — EUROPEAN PART: Dv.-Pech. (Kargopol'), Lad.-Ilm., U. V., V.-Don, V.-Kama, Transv., L. Don, M. Dnp.

In experimental sowings of basidiospores from Populus nigra on Larix, Klebahn obtained bright yellow-orange aecia; the aeciospores failed to infect P. tremula, P. alba and P. canescens, whereas P. nigra, P. canadensis, and P. balsamifera were readily and heavily infected.

(367)

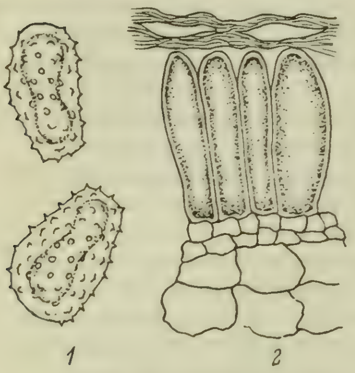


FIGURE 146. **Melampsora larici-populina** Kleb.:

1 — urediospores on **Populus nigra** L.; 2 — teliospores on **P. candicans** Ait.; × 600. (Orig.)

(369)

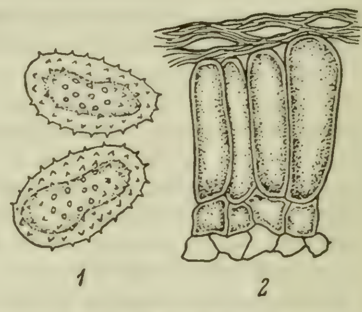


FIGURE 147. **Melampsora ıllii-populina** Kleb. on **Populus nigra** L.:

1 — urediospores; 2 — teliospores; × 600. (Orig.)

26. **Melampsora allii-populina** Kleb., Ztschr. Pflanzenkr. XII, 1902, S. 22, Fig. 2 (S. 26); Fischer, Ured. Schweiz, 1904, S. 504; Sacc., Sylloge, XVII, 1905, S. 266; Bubák, Rostpilze Böhmens, 1908, S. 207; Hariot, Uréd., 1908, p. 264; Liro, Ured. Fenn., 1908, p. 527; Migula, Kryptog.-Fl. Deutschl. III, 1, 1910, S. 484, Taf. XII, Fig. 2—4; Grove, Brit. Rust Fungi, 1913, p. 347, fig. 260; Trotter, Fl. Ital. Crypt. Ured., 1914, p. 402; Klebahn, Kryptogfl. M. Brandb. Va, 1914, S. 764, Fig. O7 (S. 782); Syd., Monogr. Ured. III, 1915, p. 348; Fragoso, Fl. Iber. Ured. II, 1925, p. 199, Fig. 97; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 155.

Syn.: Caeoma allii-ursini Winter, Pilze Deutschl. I, 1881, S. 255, pr. p.

Caeoma alliorum Link, pr. p.

Caeoma ari-italici (Duby) Winter, Pilze Deutschl., 1882, S. 256; Syd., Monogr. Ured. IV, 1924, p. 373.

Uredo allii-populina Arth., Résult. scient. Congr. intern. bot. Vienne 1905, 1906, S. 338.

Biol. Schroeter, Pilze Schles. I, 1889, S. 363, 377; 71. Jahresber. Schles. bot. Ges., 1893, S. 32; Klebahn, Jahrb. Hamburg, wiss. Anst. XX, 3, 1902, S. 6; Ztschr. Pflanzenkr. XV, 1905, S. 102; Wirtswechs. Rostpilze, 1904, S. 412; P. Cruchet, Bull. Soc. Vaudoioe sci. natur. LVI, 1928, p. 485.

Spermagonia subepidermal, deeply universal, connoid or almost discoid, as wide as high, 60—90μ.

Aecia folicaulicolous, on light-yellow spots, usually in groups, about 1 mm,
369 surrounded by remnants of the raised epidermis, bright orange-red.
Aeciospores globoid, ovoid-globoid, slightly angular, $17-23 \times 14-19\mu$; spore wall about 2μ thick, occasionally thicker, conspicuously thickened in places; verrucules low, about 0.5μ wide, at approximately 1μ intervals.

Uredia hypophyllous, also epiphyllous, round, about 1 μ, convex, bright orange-red, surrounded by remnants of the torn epidermis. Urediospores usually elongate, digitate, rarely ovoid, 24 — 38 × 11 — 18 μ; wall 2 — 4 μ thick, often irregularly thickened but not at the equator, thinner and smooth at the apex; verrucules 2 — 3 μ apart. Paraphyses 50 — 60 μ long, usually capitate (heads 14 — 16 μ) on thin (3 — 5 μ) pedicels, wall 2 — 3 μ thick.

Telia subepidermal, mostly hypophyllous, solitary or in groups, scattered over entire frond, slightly protruding, 0.25 — 1 mm, black-brown, not shiny. Teliospores irregularly prismatic, rounded at both ends, 35 — 60 × 6 — 10 μ; spore wall light brown, about 1.0 — 1.5 μ thick, sometimes slightly thickened at apex, but not exceeding 2 μ; germ pore inconspicuous (Figure 147).

Heteroecious. Aecia on species of **Allium**; uredio- and teliospores on **Populus nigra** L. and **P. canadensis** Moench. In cultures readily passed onto **P. balsamifera** L.

General distribution: Europe, Asia (Transc., Far East).

On **Allium cepa** L. — EUROPEAN PART: M. Dnp. (Kursk Region), V.-Don (Bashmakovo (see **Caeoma alliorum** Link.)).

On **Arum orientale** M. B. — EUROPEAN PART: Crim. (vicinity of Simferopol').

On **Populus nigra** L. — EUROPEAN PART: V.-Don (Ul'yanovsk, Kharkov), Transv. (Kinel'), Urals, L. V. (Astrakhan, Bykovo, etc.), L. Don (Novocherkassk), U. Dnp. (Oster), M. Dnp. (Kursk, Poltava), Bl., Crim. (Simferopol'); CAUCASUS: W Trans. (Sochi, Sukhumi), E Transc. (Salyany), S Transc. (Armenian SSR).

On **Populus pyramidalis** Roz. — EUROPEAN PART: V.-Don (Voronezh), M. Dnp. (Priluki), Crim. (Simferopol' (aecia on **Arum**)); CAUCASUS: Cisc. (Ordzhonikidze), E Transc. (Mardyakany, Lenkoran).

On **Populus laurifolia** Ldb. — FAR EAST: Uss. (Voroshilov).

On **Populus suaveolens** Fisch. — FAR EAST: Uss. (Khabarovsk, Novokievskoe).

On **Populus** sp. — FAR EAST: Uss. (Voroshilov).

In experimental sowings of basidiospores from **Populus nigra** Klebahn obtained aeciospores on **Allium schoenoprasum** L., **A. vineale** L., and **A. cepa** L. The aeciospores obtained from **A. schoenoprasum** proved infective for **Populus nigra** L., **P. canadensis** Moench., and **P. balsamifera** L., but failed to attack **Salix fragilis** L. and **S. pentandra** L.; basidiospores
370 from **Populus monilifera** produced aecia on **A. cepa** L., **A. vineale** L., **A. schoenoprasum** L., and **A. ascalonicum** L. According to Cruchet the fungus produces aecia on **Allium** and **Arum**.

ADDENDUM TO SPECIES OF MELAMPSORA ON SALICACEAE

Melampsora salicina Lév., Ann. sci. natur. III, sér. VIII, 1847, p. 375; Kleb., Kryptogfl. M. Brandb. Va, 1914, S. 803; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 156.

Collective species break up into many species and races, morphologically resembling each other, but distinguished by the hosts of the aecial stage

and by the species of Salix which they parasitize. To this species belong the collective Melampsora, producing in the majority of cases only urediospores, more accurate determination of which was not possible on the basis of morphological features alone.

On Salix polaris Wahlb. — FAR EAST: Kamch.

On Salix pallasii Anders. — FAR EAST: Kamch.

On Salix myrsinites L. — W SIBERIA: Alt.

On Salix cuneata Turcz. — FAR EAST: Kamch.

On Salix glauca L. — EUROPEAN PART: Kar.-Lap. (Khibiny Mts.); W SIBERIA: Alt. ([former] Oirot Autonomous Region).

On Salix lanata L. — EUROPEAN PART: Kar.-Lap. (Khibiny Mts.)

On Salix krylovii E. Wolf — W SIBERIA: Alt.; ARCTIC: Chuk.

On Salix phylicifolia L. — EUROPEAN PART: Kar.-Lap. (Khibiny Mts.), Lad.-Ilm. (Leningrad Region), Dv.-Pech. (Vologda Region); W SIBERIA: Ob, Irt.; E SIBERIA: Ang.-Say.

On Salix parallelinervis Floder — FAR EAST: Kamch.

On Salix chlorostachya Turcz. — E SIBERIA: Ang.-Say. (Balagansk District).

On Salix arbuscula L. — W SIBERIA: Alt.

On Salix nigricans (Sm.) Enand. — EUROPEAN PART: Kar.-Lap., Lad.-Ilm., V.-Kama.

On Salix caprea L. — EUROPEAN PART: Kar.-Lap., Lad.-Ilm., Dv.-Pech., U. V., V.-Kama, Transv., U. Dnp., M. Dnp., V.-Don, L. Don, Balt., U. Dns.; CAUCASUS: Cisc. (Voroshilovsk), W Transc.; W SIBERIA: Ob, U. Tob., Irt., Alt.; E SIBERIA: Ang.-Say., Dau.; FAR EAST: Uss., Kamch., Uda, Sakh.

On Salix hultenii Flod. — FAR EAST: Kamch.

On Salix cinerea L. — EUROPEAN PART: Lad.-Ilm., U. V., V.-Don, U. Dnp., M. Dnp. Balt., L. Don, U. Dns.; W SIBERIA: Irt.

On Salix aurita L. — EUROPEAN PART: Lad.-Ilm. (Leningrad and Kalinin regions).

On Salix livida Whlb. — EUROPEAN PART: Lad.-Ilm. (Leningrad Region), V.-Kama (Kirov Region), M. Dnp. (Poltava).

On S. xerophila Flod., S. depressa L., S. lividae Whlb., S. starkeana Willd., S. cinerescens (W) Flod. — EUROPEAN PART: Lad.-Ilm. (Leningrad Region), V.-Kama (Kirov Region), V.-Don (Tambov and Ryazan regions), U. Dnp. (Minsk); W SIBERIA: Ob, Alt.; E SIBERIA: Ang.-Say.; FAR EAST: Kamch.

On S. myrtilloides L. — EUROPEAN PART: Lad.-Ilm. (Leningrad Region), Dv.-Pech. (Vologda Region) (on leaves and flowers, urediospores
371 $9-15 \times 10-16\,\mu$, the fungus similar to Melampsora bigelowii Thüm.).

On Salix pyrolifolia Ldb. — W SIBERIA: Alt. (Oirot Autonomous Region).

On S. rosmarinifolia L. — E SIBERIA: Ang.-Say. (Tuva Autonomous Region) (urediospores globoid, ellipsoid, ovoid, $8-15 \times 12-16\,\mu$, wall uniformly verrucose, up to $2.5\,\mu$ thick; capitate paraphyses $32-45\,\mu$ long, head-width $14-17\,\mu$, wall up to $6\,\mu$ thick).

On S. gracilistyla Miq. (= S. thunbergiana Blume) — FAR EAST: Uss.

On S. viminalis L. — EUROPEAN PART: Lad.-Ilm. (Leningrad Region), M. Dnp., U. Dns. (Ternopol' Region); FAR EAST: Okh., Uss.

On S. sachalinensis Schm. — ARCTIC: Chuk.

On S. dasyclados Wimm. — EUROPEAN PART: V.-Kama (Komi ASSR).

On S. caspica Pall. — W SIBERIA: Irt. (Karaganda Region).

On S. caesia Vill. (=S. minutiflora Turcz. — W SIBERIA: Alt.

On S. acutifolia Willd. — EUROPEAN PART: Lad.-Ilm., U. V., V.-Kama, V.-Don, M. Dnp., U. Dnp. (Minsk: botanical garden).

On S. alba L. — EUROPEAN PART: U. Dns. (Drogobych Region).

On S. dolichostyla Seem. — FAR EAST: Okh.

On S. pentandra L. — EUROPEAN PART: Lad.-Ilm. (Leningrad Region), Balt.

On S. purpurea L. — EUROPEAN PART: Balt.

On S. phylicifolia × glauca — EUROPEAN PART: Kar.-Lap. (Khibiny Mts.).

On S. caprea × phylicifolia — EUROPEAN PART: Kar.-Lap., Lad.-Ilm. (Leningrad Region); W SIBERIA: Ob.

On S. purpurea × viminalis — EUROPEAN PART: U. Dnp. (Minsk: botanical garden).

On S. triandra × viminalis — EUROPEAN PART: U. Dnp. (Minsk: botanical garden).

On Salix sp. — EUROPEAN PART: Dv.-Pech., Kar.-Lap., Lad.-Ilm. U. V., V.-Kama, L. Don, Urals, U. Dnp., Balt., U. Dns. (Ternopol' Region); CAUCASUS: E Transc., S Transc.; W SIBERIA: Ob, Irt., Alt.; E SIBERIA: Ang.-Say., Dau.; FAR EAST: Okh. (Bering I.), Uss.; ARCTIC: Arc. Sib.; CENTRAL ASIA: Kara K., Ar.-Casp., Syr D., Pam.-Al. (Gorno-Badakhshan Autonomous Region).

Melampsora tremulae Tul., Ann. sci. natur. 4, sér. II, 1854, p. 95; Klebahn, Kryptogfl. M. Brandb. Va, 1914, S. 767 (Syn.: Melampsora aecidioides (DC) Schroet., Pilze, I, 1885—1889, S. 362).

This collective species includes Melampsora larici-tremulae Kleb., M. pinitorqua Rostr., M. rostrupii Wagn., and M. magnusiana Wagn. Urediospores are uniformly verruculose, roundish. Uredio- and teliospores on Populus tremula L., P. alba L. and on other species of Populus.

On Populus tremula L. — EUROPEAN PART: Kar.-Lap., Lad.-Ilm. (Leningrad Region), Dv.-Pech., U. V., V.-Kama, V.-Don (Tula, Ryazan, and Tambov regions), Transv., U. Dnp., M. Dnp., U. Dns. (Lvov and Ternopol' regions), Balt., L. Don., Crim., Urals; W SIBERIA: U. Tob., Ob, Irt., Alt.;
372 E SIBERIA: Ang.-Say.; FAR EAST: Kamch., Uss.

On Populus alba L. — EUROPEAN PART: Lad.-Ilm., M. Dnp., U. Dnp., L. Don, L. V.; CAUCASUS: E Transc.; CENTRAL ASIA: Syr D., Balt., Pam.-Al.; W SIBERIA: Alt., Irt.

On Populus canescens Smith. — EUROPEAN PART: Balt.

On P. sieboldii Miq. — FAR EAST: Sakh. (S Sakhalin).

Melampsora populina (Pers.) Lév, Ann. sci. natur. sér. 3, VIII, 1847, p. 375; Klebahn, Kryptogfl. M. Brandb., Va, 1914, S. 761.

Urediospores elongate, smooth at apex. On Populus nigra L., P. canadensis Moench., P. balsamifera L., and on other species (except on P. tremula and P. alba). This collective species includes Melampsora larici-populina Kleb. and M. alii-populina Kleb.

On Populus nigra L. — EUROPEAN PART: U. V. (Moscow Region), V.-Kama (Kirov Region), Balt.

On P. suaveolens Fisch. — EUROPEAN PART: U. Dnp. (Smol'yany).
On P. angulata (?) — EUROPEAN PART: U. Dns. (Lvov Region).

Caeoma laricis (West.) Hartig, Wicht. Krankh. d. Waldbäume, 1874, S. 93.
Uredio- and teliospores on Populus and Salix.
On Larix decidua Mill. — EUROPEAN PART: Lad.-Ilm. (Leningrad Region), Balt.
On Larix sibirica Ldb. — EUROPEAN PART: Lad.-Ilm. (Leningrad Region).
On Larix dahurica Turcz. — EUROPEAN PART: Lad.-Ilm. (Leningrad Region); FAR EAST: Uss.
On Larix sp. — EUROPEAN PART: Lad.-Ilm. (Leningrad Region).

Caeoma alliorum Link, Spec. plant. II, 1825, p. 7.
Uredio- and teliospores on Populus and Salix.
On Allium sativum L. — EUROPEAN PART: Balt.
On Allium platyspathum Schrenk — CENTRAL ASIA: Syr D. (Osh Subregion).
On Allium fistulosum L. — EUROPEAN PART: Balt.
On Allium monadelphum Turcz. — CENTRAL ASIA: Syr D. (Osh Subregion).
On Allium sp. — EUROPEAN PART: U. Dnp. (Chernigov Region).

On Saxifraga (Saxifragaceae)

27. Melampsora vernalis Niessl. apud Winter, Pilze Deutschl. 1881, S. 237; Sacc., Sylloge, VII, 1888, p. 592; Grove, Brit. Rust Fungi, 1913, p. 357; Klebahn, Kryptogfl. M. Brandb. Va, 1914, S. 811, 909, Fig. O25 (S. 812); Syd., Monogr. Ured. III, 1915, p. 386; Fragoso, Fl. Iber. Ured. II, 1925, p. 229, fig. 105; Dietel, Jahresber. Ver. Naturk. Zwickau, 1928—1930, Separat, p. 6, fig. 2; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 45, 213.

Syn.: Melampsora saxifragarum Schroet., Pilze Schles. I, 1889, S. 375; Fischer, Ured. Schweiz, 1904, S. 511; Bubák, Rostpilze Böhmens, 1908, S. 209; Migula, Kryptog.-Fl. Deutschl. III, 1, 1910, S. 486; Hariot, Uréd., 1908, p. 258; Liro, Ured. Fenn., 1908, p. 553; Trotter, Fl. Ital. Crypt. Ured., 1914, p. 398 (the uredial stage omitted in all descriptions).

Caeoma saxifragarum Schl., Fl. Berol. II, 1824, p. 121; Sacc., Sylloge,
373 VII, 1888, p. 864.

Biol. Plowright, Journ. Roy. Hort. Soc., 1890, p. CIX; Dietel, Mitt. Thüring. bot. Ver., N. F., VI, 1894, S. 5 (Separat); Forstl. naturw. Ztschr., 9, 1895, S. 374; Klebahn, Ztschr. Pflanzenkr. XXII, 1912, S. 339.

Spermagonia hypophyllous, flat, yellow, about 180μ wide and 75μ high.

Aecia (caeoma) hypophyllous, round or elliptical, 0.25—0.75 mm, surrounded by remnants of the torn epidermis, solitary or scattered over entire frond. Aeciospores catenulate, round or oval in section, $17-27 \times 16-22\mu$; spore wall colorless, up to 2μ thick, its very dense and and thin verrucose appearance conferred by the extremely fine rods enclosed in the outer layer; contents orange-colored (Figure 148).

Urediospores absent.

Telia amphigenous, partly minute (0.05 mm), and partly large (up to 0.5 mm), the latter evident in dark brown crusts. Teliospores develop subepidermally, forming an irregular layer; some spores wedge in between the others; small sori, often situated under the stomata, sometimes consist of a few cells, frequently of two hemispherical cells forming a large body resembling the spores of Pucciniastrum; the sori are often built of many spores, flattened by mutual pressure. As shown by Dietel, these bodies (or sori) involve the production of dual (paired) spores borne on a common hypha, while one spore is slightly higher than the other; the dual spores aggregate, sometimes, in heaps of 2—5 pairs on a common hypha and in this case, examination from above gives the impression of a bicellular or multicellular spore. The spores in the large, complex, palisade-like heaps are prismatic with rounded ends, $24-50 \times 9-14\,\mu$, and in the small heaps ellipsoid or globoid, varying in size and shape, $17-30 \times 17-25\,\mu$; spore wall yellowish-brown, with a conspicuous apical pore.

On Saxifraga granulata, autoecious.

General distribution: Europe.

On Saxifraga granulata L. — EUROPEAN PART: Balt. (Latvian SSR: environs of Riga; Estonian SSR: near Tallin, Saare I.).

The connection of aecia with the teliospores was experimentally proved by Dietel and Klebahn. Paired teliospores have been reported by Dietel also in Melampsoridium betulae, Melampsora euphorbiae-dulcis, M. larici-tremulae, M. larici-populina, M. reticulatae, and M. epitea, but not in M. euphorbiae or M. lini.

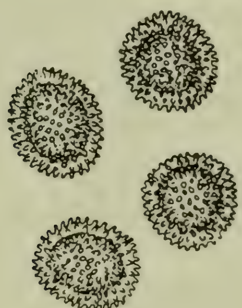


FIGURE 148. Melampsora vernalis Niessl. on Saxifraga granulata L. Aeciospores, × 600. (Orig.)

(374)

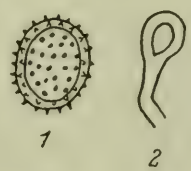


FIGURE 149. Melampsora hirculi Lind. on Saxifraga hirculus L.:

1 — urediospores; 2 — paraphyses. (After Klebahn)

28. **Melampsora hirculi** Lind., Acta Soc. fauna et flora Fenn. 22, 3, 1902, p. 19; Sacc., Sylloge, XVII, 1905, p. 264; Liro, Ured. Fenn., 1908, p. 555; Migula, Kryptog.-Fl. Deutschl. III, 1, 1910, S. 388; Syd., Monogr. Ured. III, 1915, p. 388; Klebahn, Kryptogfl. M. Brandb. Va, 1914, S. 815, Fig. O26 (S. 812); Fragoso, Fl. Iber. Ured. II, 1925, p. 230 in nota; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 213.

Spermagonia and aecia unknown.

Uredia yellow, round, usually epiphyllous, scattered, small, producing no spots, surrounded by numerous, colorless, thick-walled ($3-4\mu$)
374 paraphyses, $40-60\mu$ long, with apical club-shaped swellings reaching 20μ in width; the wall thickened at the apex, to 8μ. Urediospores globoid, ellipsoid, to obovoid, $18-25 \times 14-19\mu$; spore wall colorless, thin, uniformly and rather densely covered with short echinules (Figure 149).

Telia are reddish-brown, later turning dark brown and finally black, flat, small, often confluent, hypophylious and on stems. Teliospores subepidermal, ellipsoid, cylindroid, angular (owing to lateral pressure), $30-52 \times 10-16\mu$; spore wall brown, rather thin, uniformly thick; pore not evident.

General distribution: USSR, Finland, Switzerland, Germany, and Mongolia (on Saxifraga hirculus).

On Saxifraga hirculus L. — EUROPEAN PART: Kar.-Lap. (Karelian ASSR), Dv.-Pech. (Arkhangel'sk Region), Lad.-Ilm. (Kalinin Region: Berezaika (!)).

On Linum (Linaceae)

29. **Melampsora lini-usitatissimi** (Pers. pr. p.) Kupr. comb. nov.

Syn.: **Melampsora lini** (Pers.) Desmaz., Plant. Crypt. No. 2049, 1850, pr. p. ; Sacc., Sylloge VII, 1888, p. 588, pr. p.; Fischer, Ured. Schweiz, 1904, S. 507, pr. p.; Bubák, Rostpilze Böhmens, 1908, S. 208, pr. p.; Hariot, Uréd., 1908, p. 258, pr. p.; Liro, Ured. Fenn., 1908, S. 556, pr. p.; Migula, Kryptog.-Fl. Deutschl. III, 1, 1910, S. 486, Taf. XI, Fig. 1, pr. p.; Grove, Brit. Rust Fungi, 1913, p. 355, Fig. 266, pr. p.; Klebahn, Kryptogfl. M. Brandb. Va, 1914, S. 806, Fig. O22 (S. 812), pr. p.; Trotter, Fl. Ital. Crypt. Ured., 1914, p. 397, pr. p.; Syd., Monogr. Ured. III, 1915, p. 381, pr. p.; Fragoso, Fl. Iber. Ured. II, 1925, p. 240, fig. 116, 117, pr. p.; Arth., Manual Rusts U. S. a. Canada, 1934, p. 57, fig. 82, pr. p.; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 263, pr. p.

Uredo miniata Pers. var. **lini** Pers., Syn., 1801, p. 216, pr. p.

Uredo lini Schum., Plant. Saell. II, 1803, p. 230, pr. p.; Arth., N. Amer. Fl. VII, 1907, p. 101; 1927, 817, pr. p.

Uredo lini DC, Fl. franç. II, 1805, p. 234, pr. p.

Xyloma lini Ehrenb., Sylvae mycol. Berol., 1818, p. 27, pr. p.

Melampsora lini Lév., Ann. Sci. natur., III, sér. VIII, 1847, p. 376, pr. p.

Melampsora lini (Schum.) Desmaz., Plant. Crypt. 1850, No. 2049, pr. p.

Melampsora lini var. **liniperda** Körn., Verhandl. Naturhist. Ver. Preuss. Rheinl. u. Westphal. XXXI, 1874, p. 83.

Melampsora liniperda Palm, Svensk bot. Tidskr., 1910, IV, p. 4.

Biol. Arthur, Journ. Mycol. XIII, 1907, p. 207; Buchheim, Ber. Deutsch. bot. Ges. XXXIII, 1915, p. 73 — 75, pr. p.; Arch. sci. physiq. et natur., Quater. période, XLI, 1916, p. 149 — 154, Zhurn. Novocherk. otd. Russk. bot. obshch., 1919, pp. 38 —40; Rashevskaya, Zashch. rast. ot vredit. V, 1, 1928, p. 107; Zemit, Agrobiologiya, 2, 1947; Sel. i semenov. 9, 1949, pp. 54 — 59; Arif, Brit. Mycol. Soc. Trans., 37, 4, 1954, p. 353 — 361; Flor, Journ. Agric. Res., 60, 9, 1940, p. 575 — 592; 73, 11 — 12, 1946,

p. 335 — 357; Phytopathology, 40, 3, 1950, p. 235 — 238; 43, 11,
375 1953, p. 624 — 628; 44, 1954, p. 469 — 471; Kruickshank, New Zealand, Journ. Sci. a. Technology, 13 sect., 34, 2, 1952, p. 128 — 133, pr. p.; Waterhouse a. Watson, Journ. a. Proc. Roy. Soc. New South Wales, 75, 3, 1942, p. 115 — 117; 77, 4, 1944, p. 138 — 144.

Spermagonia small, pale, inconspicuous, numerous, globoid, without ostriolar filaments, subepidermal.

Aecia caemoid, i. e., without peridium, mainly hypophyllous, scattered, rather pale, not as conspicuous as the uredia, with which they may easily be confused. According to Sydow aeciospores are globoid or subgloboid, thinly verrucose, with pale orange contents, $21-28 \times 10-27\mu$; spore wall about 1μ thick.

Uredia amphigenous, also on stems, round or oblong, protruding from under the epidermis, orange-colored, surrounded by thin peridium, as if underlying the cells of the torn epidermis; peridial cells thin-walled, $12-13\mu$ high, about 8μ thick. Urediospores globoid to ellipsoid, finely verruculose with orange-colored contents, $16-27 \times 13-18\mu$; spore wall colorless, 1.5μ thick. Paraphyses $40-50\mu$ long, capitate, heads $18-23\mu$ wide.

Telia amphigenous, mostly caulicolous, scattered or confluent in large crusts, reddish-brown, later dark brown, almost black. Teliospores prismatic, $56-78$ $(84) \times 7-8$ $(10)\mu$, rounded at both ends, especially at the lower end, contained in crusts; spore wall pale brownish-yellow, about 1.5μ thick, somewhat thickened (up to 3μ) and of a darker tone at the upper end. The spore dimensions differ on the individual species of **Linum** (see below) (Figure 150).

0, I, II, III on cultivated flax and closely related species; teliospores are overwintering.

Melampsora lini (Pers.) Desmaz. s. l. is a collective species, its individual representatives (subspecies, forms) being distinguished chiefly by morphological features and specialization.

Koernicke (Land- u. forstwirtsch. Ztg. Prov. Preussen, Jahrb. 1865; Verhandl. Naturhist. Ver. Preuss. Rheinl. u. Westphal., XXXI, 1874, S. 83) in 1865, having noticed the longer teliospores on **Linum usitatissimum** than on the form Linum **catharticum**, recorded it as a separate variety, M. lini Tul. var. liniperda Körn. Fuckel (Symholae mycologicae, 1869, p. 44) designated the former form "a. **major**," "all parts of which are larger than in the following, especially the teliospores (72μ long), whereas in the latter (b. **minor** on **Linum catharticum**) teliospores are only 54μ long." Palm (l. c.) concluded that the species M. lini* **liniperda**, on **Linum usitatissimum** should be recognized as independent, and named it M. **liniperda** (Körn.) Palm. Palm failed to infect L. **usitatissimum** with urediospores from L. **catharticum**. Moreover, the teliospores differ significantly in size; in the former they measure $60-80 \times 6-8\mu$, in the latter $35-50 \times 7-10\mu$.

Arthur (l. c.) sowed teliospores from L. **usitatissimum** on L. **lewisii** Pursh (= L. **perenne** Nutt.) and obtained spermagonia and aecia, and later obtained with them spermagonia and aecia also on L. **usitatissimum**. Aecia of M. **lini-usitatissimum** on flax were first recorded in the USSR by V. Rashevskaya.

A. Buchheim carried out experimental infections in Switzerland in 1914 (l. c. 1915). In his reports it is stated that urediospores from **Linum**
376 **catharticum** infect only L. catharticum. He sowed on many species of Linum but the protocols are not available, and it is only indicated that the form on Linum catharticum is not identical with the forms on L. usitatissimum, L. alpinum, L. austriacum, L. narbonense and L. tenuifolium; but, for some reason or other, no mention is made of L. campanulatum, L. capitatum, **L. lewisii**, **L. maritimum**, **L. flavum**, and **L. sibiricum**, which proved unsusceptible to infection in these experiments. The urediospores from **L. alpinum** infected only **L. alpinum**, those from L. tenuifolium only L. tenuifolium. Urediospores from L. strictum do not infect any of the Linum species (experimental sowing was not performed on Linum strictum).

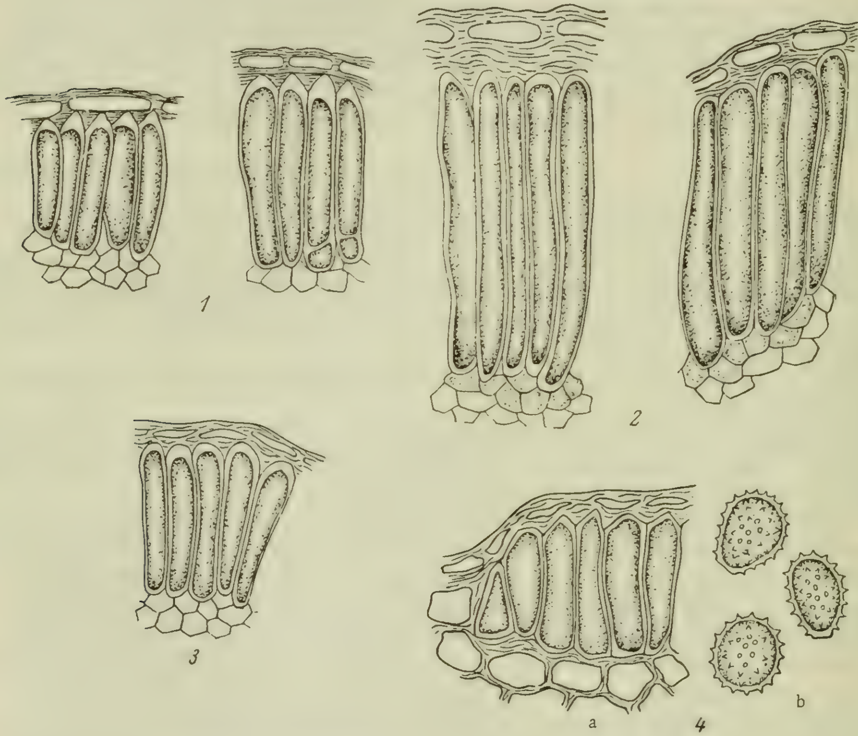


FIGURE 150. **Melampsora lini-usitatissimi** (Pers. pr. p.) Kupr. Teliospores:

1 — on **Linum usitatissimum** L. (collected in various habitats; 2 — on **L. perenne** L. (collected in various habitats); 3 — on **L. austriacum** L.; 4, a — on **L. nervosum** W. et K.; 4, b — urediospores. 1, 3, 4, a × 350; 2, 4, b × 600. (Orig.)

In experiments carried out in Switzerland in 1915, Buchheim (l. c., 1916) sowed teliospores of **M. lini** s. l. on **L. alpinum**, whereupon spermagonia and caeomoid aecia were obtained on **L. alpinum**. **L. austriacum**, **L. sibiricum**, and **L. perenne**, though not on all experimental specimens of the species listed; no infection was recorded on **L. usitatissimum**, **L. tenuifolium**, or

L. catharticum. On the basis of his own and Palm's experiments Buchheim suggested establishment of the following forms: f. liniperda (Körn) Palm on L. usitatissimum; f. cathartici on L. catharticum L.; f. perennis on L. alpinum L., L. austriacum L., L. perenne L. and L. sibiricum DC; f. tenuifolii on L. tenuifolium L.; f. stricti on L. strictum L.

377 Urediospores produced on Linum catharticum are considerably shorter than those on other species; 57% of them measure between 15.36 and 17.92 μ, 35% between 17.92 and 20.48 μ, whereas on L. alpinum, L. tenuifolium, and L. strictum only 1 — 3% of the urediospores measure from 15.38 to 17.92 μ in length, the majority from 20.48 to 23.04 μ (55.37 and 42%), and fewer from 23.04 to 25.60 μ (22.20 and 34%). In his subsequent work Buchheim (l. c., 1919) reports the dimensions of teliospores produced on **Linum pallasianum** Schultes and the average length of urediospores on **Linum catharticum** (17.4 μ), on L. alpinum (21.9 μ), on L. tenuifolium (22.6 μ), on L. strictum (22.5 μ), and on L. pallasianum (21.5 μ).

Our measurements showed the following length of urediospores (in μ):

on **L. usitatissimum** L.	18 — 27	(maximum about 21%)
on **L. catharticum** L.	15 — 21	(96% between 18 and 21)
on **L. nervosum**, W. et K.	16 — 27	(maximum about 21.6)
on **L. corymbulosum** Reichb.	18 — 30	(maximum between 21 and 24)
on **L. luteolum** M.B.	18 — 30	(maximum between 21 and 24)
on **L. olgae** Juz.	12.2 — 27	(maximum about 21.6)

Thus, the form on L. catharticum is distinguished by shorter urediospores than the forms examined on all other species of **Linum** in which the urediospores are of similar length.

The length of teliospores in the telia decreases from the center toward the periphery.

The mean length of teliospores in the sorus obtained from a large number of measurements is as follows (in μ):

on **L. usitatissimum** L.	57 — 78
on **L. angustifolium** Huds.	54 — 72
on **L. perenne** L.	72 — 84
on **L. strictum** L.	56.7 — 73
on **L. olgae** Juz.	51 — 70
on **L. nervosum** W. et K.	51 — 67.5
on **L. austriacum** L.	48 — 69
on **L. corymbulosum** Reichb.	48 — 60
on **L. luteolum** M.B.	39 — 60
on **L. catharticum** L.	48 — 57
on **L. pallescens** Bge.	39 — 57

Evidently, the teliospores on **Linum** catharticum are shorter than on L. perenne, L. usitatissimum, the native species L. angustifolium, as well as L. strictum and L. olgae, but scarcely differ in length from those of other **Linum** species.

Hence, the fungus on Linum usitatissimum and on the native species of Linum may be separated in an independent species — Melampsora lini-usitatissimi, comb. nov. (type species on Linum usitatissimum L.). Separation of the cultivated flaxrust is justified also by the strict adaptation of the fungus and extreme harmfulness. The rust adapted to Linum catharticum and to certain other wild species of Linum may be separated into another species — Melampsora lini-cathartici, comb. nov. (type species on Linum catharticum — Melampsora lini (Pers.) Desmaz.). This fungus does not pass onto Linum usitatissimum or species closely related to it.

The characteristic morphology and specialization of the fungi on L. usitatissimum and other flaxes provided the necessary criteria for separating the following forms included in the composition of Melampsora lini-usitatissimum (Pers. pr. p.) comb. nov.

378 Forma liniperda (Korn.) Palm. — on Linum usitatissimum. Teliospores 57—78 μ long.

Forma perennis Buchh. — on L. perenne L. and L. austriacum L. Teliospores 72—84 μ long.

Forma stricti Buchh. — on L. strictum L. (not on L. corymbulosum Rchb.). Teliospores 56—73 μ long.

General distribution: Eurasia, Australia, New Zealand — in all known regions of flax cultivation.

The fungus is distinguished by the severe damage it inflicts and the reduction of both yield and quality of the fibers. Dissemination of the pathogens is greatly enhanced by spreading of the flax in fall, on the clover fields on which flax is subsequently grown. Control measures are mainly preventive.

In the USSR the fungus is found wherever flax is grown; also on wild species of Linum, from which, according to available data, it does not pass onto the cultivated stands. Contamination from Linum angustifolium Huds. is not excluded.

On Linum usitatissimum L., cult. — ubiquitous, particularly: EUROPEAN PART: Dv.-Pech., Lad.-Ilm., Balt., U. V., V.-Kama, U. Dnp., M. Dnp., V.-Don, Transv., Crim.; CAUCASUS; W SIBERIA: Ob, Irt., Alt.; E SIBERIA: Ang.-Say.; FAR EAST; CENTRAL ASIA: Syr D., Pam.-Al., and other flora regions.

On Linum angustifolium Huds. — CAUCASUS: E Transc. (Azerbaijan SSR).

On Linum perenne L. (incl. L. sibiricum DC) — E SIBERIA: Ang.-Say. (Minusinsk), Dau. (Kyakhta, Vitim River); CENTRAL ASIA: Balkh. (Dzhambul), Dzv.-Tarb. (Kazakh SSR), Pam.-Al. (Tadzhik SSR, Kirghiz SSR).

On Linum austriacum L. — EUROPEAN PART: Crim.; CAUCASUS: Cisc.

On Linum nervosum W. et K. — EUROPEAN PART: M. Dnp., V.-Don, Crim.; CAUCASUS: Cisc.

On Linum strictum L. (non L. corymbulosum Rchb.).— EUROPEAN PART: Crim.

On Linum olgae Juz. — CENTRAL ASIA: Pam.-Al. (Zeravshan and Alai Ranges).

The biology of M. lini-usitatissimum and M. lini-cathartici was studied by several scientists (see above). More recently, interesting works have been published by V. Zemit, dealing with the various degrees of sensitivity of flax seeds to extracts of rust-infected tissues. The physiological races of rusts on the cultivated flax — Melampsora lini-usitatissimi — have been revealed by extensive studies of the flora (Flora, l. c.), carried out by Kruickshank (l. c.) and other authors.

On Linum

30. Melampsora lini-cathartici (Buchh.) Kupr. comb. nov.

Syn.: **Melampsora lini f. cathartici** (Pers.) Buchheim, Arch. sci. physiq. et natur., Quater. période, XLI, 1916, p. 149—154.

Melampsora lini-tenuifolii (Pers.) Buchh., l. c., 1916.

Melampsora lini (Schum.) Desmaz., Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 263, pr. p.; for further pertinent literature see at **Melampsora lini-usitatissimi** (Pers. pr. p.) Kupr.

379 Spermagonia and aecia as in **M. lini-usitatissimi** (Pers. p.) Kupr.

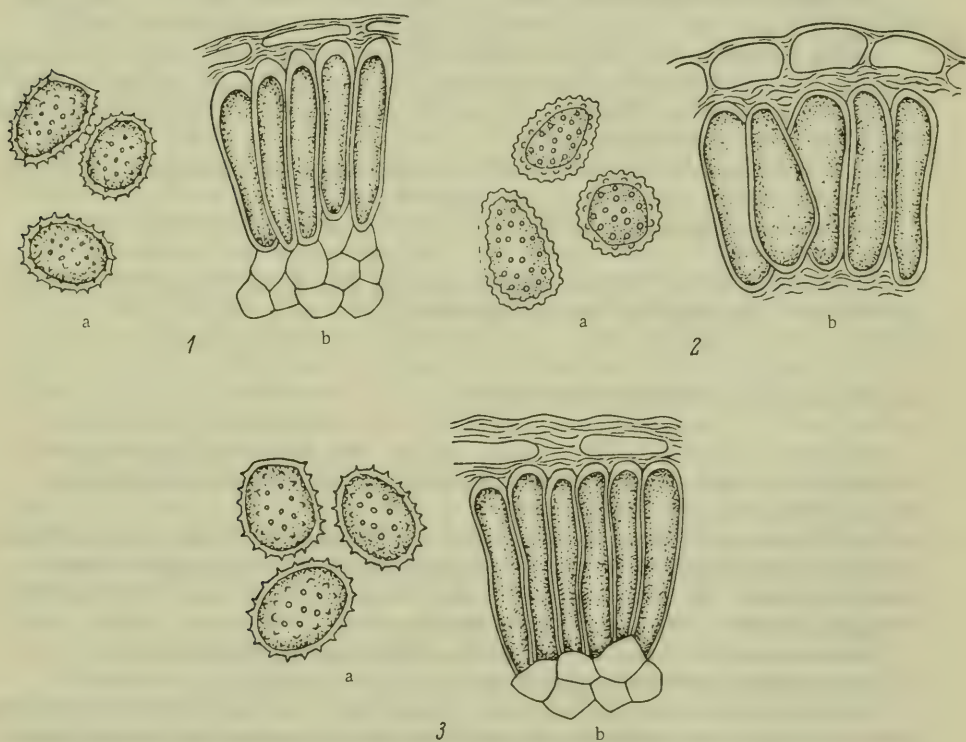


FIGURE 151. **Melampsora lini-cathartici** (Buchh.) Kupr. Uredio- (a) and teliospores (b):
1 — on **Linum catharticum** L.; 2 — on **L. corymbulosum** Rhb.; 3 — on **L. heterosepalum** Rgl.; × 600. (Orig.)

Uredia as in the preceding species. Urediospores on **Linum catharticum** L., 15–21 μ, on other species 16–30 μ wide (see note to preceding species).

Telia as in preceding species, somewhat smaller, dark brown. Teliospores (39) 48–57 (60) $\times$ 8–12 μ (Figure 151).

The species is differentiated from M. lini-usitatissimi by shorter teliospores and by specialization; it does not pass onto **Linum usitatissimum**. Type on **Linum catharticum** L.

According to Buchheim and other authors two forms can be distinguished, similar in their morphology but parasitizing different species of **Linum**:

Forma cathartici Buchh. – on **Linum catharticum** L. and **L. corymbulosum** Rchb. Teliospores 48–60 μ long.

Forma tenuifolii Buchh. – on **Linum tenuifolium** L., **L. luteolum** M. B., and **L. pallescens** Bge. Teliospores 39–60 μ long.

Differentiation of these two forms and of the form Melampsora lini-usitatissimi is possible only with the aid of artificial cultures.

On **Linum cartharticum** L. – EUROPEAN PART: Kar.-Lap., Balt., Dv.-Pech., Lad.-Ilm., U.V., V.-Dnp., U.Dns., M.Dnp.; CAUCASUS: Cisc., E. Transc.

On **Linum pallescens** Bge. – W SIBERIA: Irt. (Akmolinsk).

On **Linum stelleroides** Planch. – FAR EAST: Uss. (Pos'et District).

On **Linum tenuifolium** L. – CAUCASUS: Georgian SSR.

On **Linum corymbolosum** Rchb. – CENTRAL ASIA: Syr D. (Namangan
380 District), Pam.-Al. (Gul'cha), Tien Shan (Aksai River near Alma-Ata).

On **Linum flavum** L. – EUROPEAN PART: V.-Don (Kursk Region; Korocha), Transv. (Tatar ASSR: Bugulma District; Chkalov Region: Buguruslan District).

On **Linum luteolum** M. B. (= L. nodiflorum Ldb.) – CAUCASUS: E Transc. (Georgian SSR, Azerbaijan SSR).

On **Linum heterosepalum** Rgl. (= L. heterosepalum tianshanicum Vved.) – CENTRAL ASIA: Tien Shan (near Alma-Ata).

On **Linum pallasianum** Schult. – EUROPEAN PART: L. Don (Rostov-on-Don).

The biology of the fungus was studied by Buchheim and other authors (see note to **Melampsora lini-usitatissimi**).

On Richinus (Euphorbiaceae)

31. **Melampsora (?) ricini** Pass., Erb. Critt. Ital. ser. II, XIV, No. 684, 1878; Syd., Monogr. Ured. III, 1915, p. 391; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 269.

Syn.: Caeoma ricini Schl., Linnaea, I, 1826, S. 612. Uredo ricini Bivona-Bernardi, Stirp. rariorum minusque cognitarum in Sicilia sponte prov. descript. Manip. III, 1815, p. 10; Trotter, Fl. Ital. Crypt. Ured., 1914, p. 449; Fragoso, Fl. Iber. Ured. II, 1925, p. 346, fig. 160.

Melampsorella ricini de-T. in Sacc., Sylloge, VII, 1888, p. 596.

Spermagonia and aecia unknown.

Uredia hypophyllous, rarely also epiphyllous, on small patches reaching 3 mm across, more conspicuous on the upper side of leaves, small, round, up to 1 mm, scattered or coalescing, frequently arranged in rings or circles, occasionally occupying extensive portions of the leaf, confluent, covered in the beginning by the epidermis but soon erumpent, later exposed, pulverulent, bright yellowish-orange. Urediospores elongate-ovoid or ellipsoid, 18–30 $\times$ 16–22 μ, yellow; wall 2–3 μ thick, densely echinulate-

verrucose. Paraphyses numerous, 40—55 μ long, capitate (head-width 16—26 μ across), colorless or faintly yellowish above; wall 2—4 μ thick, smooth.

Teliospores unknown.

On Ricinus communis L. and other castor-plant species in the Mediterranean area (France, Italy, Spain, Portugal, Algeria, Morocco, Egypt), central and southern Africa, and India.

In view of the spreading cultivation of castor-plant in the USSR, appearance of the fungus in this area may be expected.

Although teliospores are unknown, the structure of the urediospores and paraphyses resembles that in the genus Melampsora.

On Euphorbia

32. Melampsora euphorbiae (Schub.) Cast. Observ. mycol. II, 1843, p. 18; Catal. plant. Marseille, p. 206; Grove, Brit. Rust Fungi, 1913, S. 353; Syd., Monogr. Ured. III, 1915, p. 378; Arth., Manual Rusts U. S. a. Canada, 1934, p. 58; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 269.

Syn.: Xyloma euphorbiae Schub. in H. Ficinus, Flora der Gegend um Dresden, II, 1823, S. 310.

Melampsora helioscopiae (Pers.) Winter, Pilze Deutschl., 1881, S. 240; Sacc., Sylloge, VII, 1888, p. 585; Fischer, Ured. Schweiz, 1904, S. 508; Hariot. Uréd., 1908, p. 256; Liro, Ured. Fenn., 1908, p. 558; Migula, Kryptog.-
381 Fl. Deutschl. III, 1, 1910, S. 485; Klebahn, Kryptogfl. M. Brand. Va, 1914, S. 808, 902; Trotter, Fl. Ital. Crypt. Ured., 1914, p. 395; Syd., Monogr. Ured. III, 1915, p. 377; Fragoso, Fl. Iber. Ured. II, 1925, p. 231; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 269.

Uredo Helioscopiae Pers., Tent. Disp. meth. fung., 1797, p. 13.

Melampsora euphorbiae-dulcis Otth, Berner Mitt., 1868, S. 70; Fischer, Ured. Schweiz, 1904, S. 510, Fig. 319; Migula, Kryptog.-Fl. Deutschl. III, 1, 1910, S. 485, Taf. XI, Fig. 3, 4; Klebahn, Kryptogfl. M. Brandb. Va, 1914, S. 810; Trotter, Fl. Ital. Crypt. Ured., 1914, p. 396, Fig. 100c; Syd., Monogr. Ured. III, 1915, p. 380, tab. XIV, Fig. 138; Fragoso, Fl. Iber. Ured. II, 1925, p. 234, Fig. 110; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 269.

Melampsora congregata Diet., Ber. Deutsch. bot. Ges. VI, 1888, S. 402; Sacc., Sylloge, XI, 1895, p. 183.

Melampsora euphorbiae-Gerardianae W. Müller, Centrbl. Bacteriol. II. Abt., XVII, 1906, S. 210; XIX, 1907, S. 452, 548, Fig. 4—9; Hariot, Ured., 1908, p. 394; Sacc., Sylloge, XXI, 1912, p. 603; Klebahn, Kryptogfl. M. Brandb. Va. 1914, S. 809; Trotter, Fl. Ital. Crypt. Ured., 1914, p. 394; Syd., Monogr. Ured. III, 1915, p. 376; Fragoso, Fl. Iber. Ured. II, 1925, p. 237, Fig. 113; Arth., Manual Rusts U. S. a. Canada, 1934, p. 58, Fig. 85; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 269.

Melampsora euphorbiae-cyparissiae Müller, Centrbl. Bacteriol. II. Abt., XIX, 1907, S. 553, 561.

Uromyces euphorbiae-connatae Speschn., Tr. Tifl. bot. sada, V, 1901, p. 165, Tab. I, Figs. 16—21.

Biol. Österr. wiss. Ztschr., 1889, 7; Mitt. Thür. bot. Ver., N. F., VI, 1894; Dietel, Forstl. naturwiss. Ztschr. 1895; Jacky, Ber. Schweiz. bot. Ges. IX, 1899, S. 27; Klebahn, Ztschr. Pflanzenkr., XVII, 1907; W. Müller, Centrbl. Bacteriol. II. Abt., XVII, 1906; XIX, 1907.

Spermagonia usually amphigenous, globoid or slightly flattened.

Aecia mostly hypophyllous, solitary, also epiphyllous and caulicolous causing the appearance of yellow-bordered reddish spots. Aeciospores catenulate, mainly globoid or ovoid, $20-24\mu$ across, up to 28μ long, delicately verruculose.

Uredia usually hypophyllous, circular or elongate, early erumpent, occasionally in rings around the central pustule, orange-yellow. Paraphyses smooth, capitate. Urediospores globoid or ellipsoid, $13-24 \times 12-20\mu$; wall colorless (or faintly stained), verrucose; pores inconspicuous.

Telia hypophyllous or amphigenous, rarely on stems, small, round or elongate, sometimes numerous, coalescing in large patches, yellowish-brown, later darker, brown to black. Teliospores single-celled, brown, cylindroid, prismatic or, when loose in structure, ellipsoid to ovoid, $18-30$ to 65μ long, $7-12$ to 22μ thick, with the wall sometimes thickened at the apex (see forms).

(382)

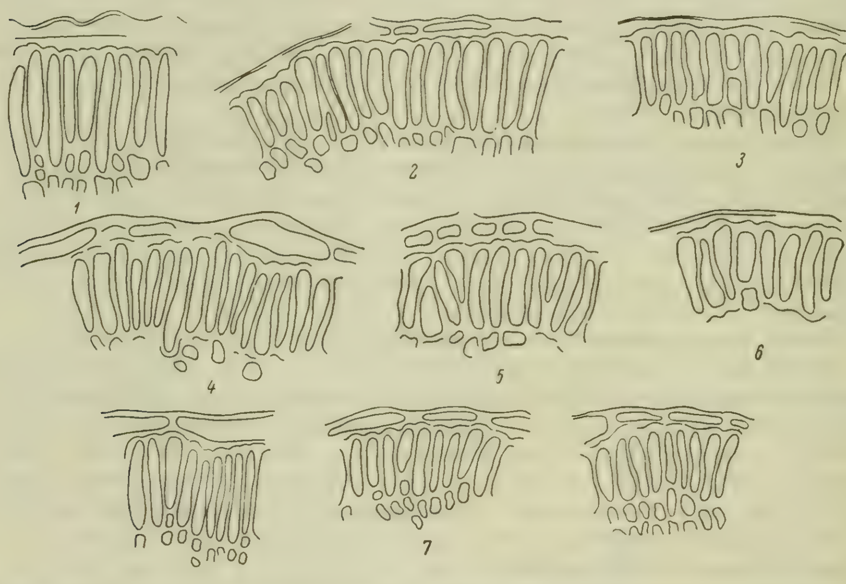


FIGURE 152. Melampsora euphorbiae (Schub.) Cast. Teliospores:

1 — on Euphorbia dendroides L.; 2 — on E. falcata L.; 3 — on E. gracilis Bess.; 4 — on E. kopetdakhi Prokh.; 5 — on E. gerardiana Jacq.; 6 — on E. ispahanica Boiss.; 7 — on E. turczaninowii Kar. et Kir. (× 250 — 300, after O. Oliferenko)

0, I, II, III — on numerous species of **Euphorbia**; in both hemispheres overwintering by teliospores. Breaks up in many forms adapted to individual sections or species of **Euphorbia**. According to Oliferenko,
382 the individual forms produce a gradual series of teliospores, according to their size; from the cylindroid, elongate on **E. dendroides**, **E. falcata** and **E. kopetdaghi** Prokh. to ovoid on **E. muricata** M. B. and **E. dulcis** L. (Figures 152 — 154). The presence on the same host of forms distinctly different in their morphology reflects the wide amplitude of variability

of the fungus Melampsora euphorbiae Cast. determined by the habitat of the host plant (Saratov, Odessa, Tambov, and Moscow regions). In some cases the fungi collected from a single host may be referred — according to the size of teliospores and other morphological features — to almost any species of Melampsora on Euphorbia. Müller, Klebahn, Jacky, and others concluded that the biological specialization does not justify the establishment of independent species. The morphological differences mentioned, in conjunction with the fungal specialization and the impossibility of identifying reliably the species described in the literature (herbarium specimens), permit us to consider Melampsora on Euphorbia a genetically collective species. We deemed it expedient to designate as Melampsora euphorbiae (Schub.) Cast. all genetically united forms of Melampsora on species of Euphorbia. Other names such as M. helioscopiae (Pers.) Winter, although given earlier, are less appropriate for they indicate the species of the host plant. A somewhat special place is occupied by M. gelmii Bres., on Euphorbia rapulum Kar. et Kir., discovered by us in the USSR and Central
383 Asia.

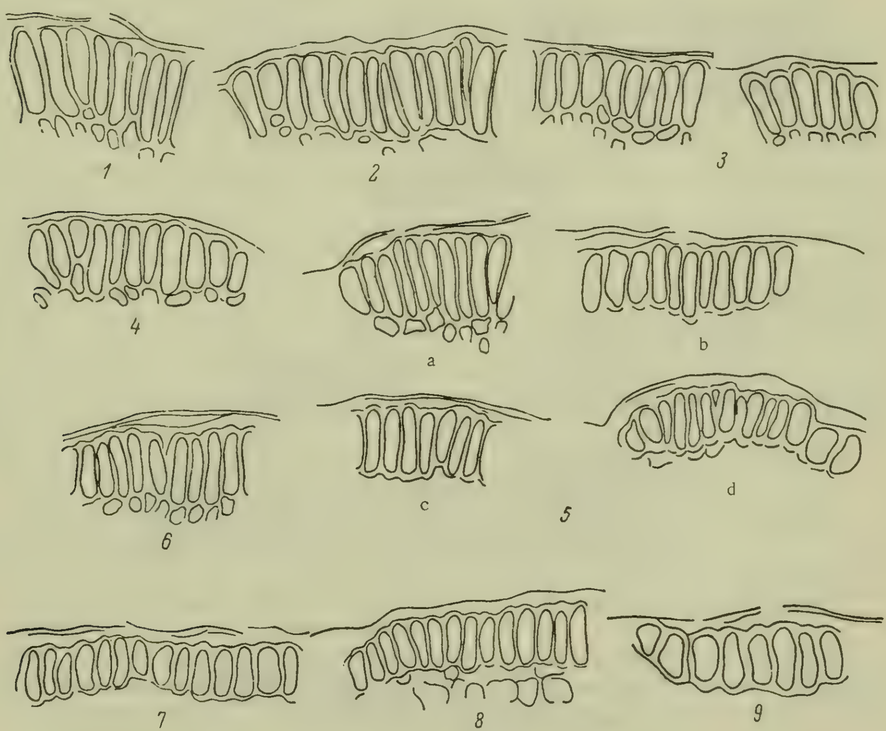


FIGURE 153. Melampsora euphorbiae (Schub.) Cast. Teliospores:

1 — on E. orientalis L.; 2 — on E. helioscopia L.; 3 — on E. latifolia C. A. M.; 4 — on E. peplis L.; 5 — on E. virgata Waldt. (collected: a — from the former Saratov Province, 31 July 1890, b — from the vicinity of Odessa, June, 1872; c — from the former Tambov Province, 15 July 1902, d — from the former Moscow Province, near the village of Mikhailovskoe); 6 — on E. esula L.; 7, 8 — on E. palustris L.; 9 — on E. nutans Lagasca. (× 250 — 300, after O. Oliferenko)

In view of the morphological and, partly, biological characteristics of the species, the following forms may be distinguished:

Forma gerardianae (W. Müller). Teliospores (25) 40 — 60 (80) × 6.5 — 12.5 μ, more or less thickened at the apex. On species of **Euphorbia** from the section **Esulae**.

Forma **helioscopiae** (Pers.) Kleb. Teliospores 37.5 — 60 (67) × 7.5 — 12 μ, not thickened at the apex. On **Euphorbia helioscopia** and on many other species of the subsection **Helioscopiae** of section **Tulocarpa**.

Forma **euphorbiae** (Cast.) s. str. Teliospores 20 — 50 (55) × 7.5 — 15 μ, not thickened at apex. On species of **Euphorbia** from section **Esulae**; in the USSR usually on **E. virgata**.

Müller (l. c.) differentiates the biological forms: **euphorbiae pepli**; **euphorbiae exiguae**, and **euphorbiae cyparissiae** W. Müller.

Forma dulcis (Otth). Teliospores 20 — 40 × 7.5 — 15 (20) μ, not thickened at apex; telia usually small, brown, densely crowded in groups. On species of **Euphorbia**, section **Tulocarpa**, and on several other species. The most typical fungus on broad-leaved forest spurge.

(384)

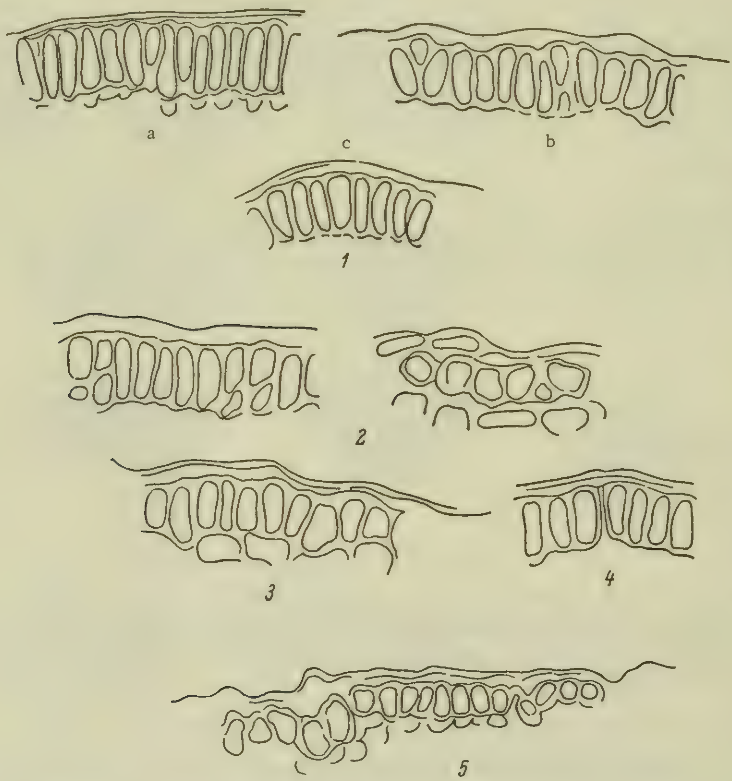


FIGURE 154. **Melampsora euphorbiae** (Schub.) Cast. Teliospores:

1 — on **E. semivillosa** Prokh. (collected: a — from the vicinity of Starobelevsk in Voroshilovgrad Region, b — from the former Kursk Province, c — from the former Moscow Province); 2 — on **E. squamosa** Willd.; 3 — on **E. pilosa** L.; 4 — on **E. alpina** C. A. M.; 5 — on **E. dulcis** (L.). (× 250 — 300, after O. Oliferenko)

To the same species should probably be referred Melampsora monticola
384 Mains (Phytopathology, 7, 1917, p. 103; Arthur, Manual Rusts U. S. a. Canada, 1934, p. 57, Fig. 83), widespread in North America.

General distribution: Europe, Asia, Africa, N America.

On Andrachne telephioides L. — EUROPEAN PART: Crim. (Sevastopol') (II).

On Euphorbia seravschanica Rgl. — CENTRAL ASIA: Pam.-Al. (Tadzhik SSR: Gissar Range, Yagnob) (II, III).

On E. monocyathium Prokh. — CENTRAL ASIA: Pam.-Al. (Kirghiz SSR: Altai Range, Bel-Aul Pass) (I).

On E. pallasii Turcz. — FAR EAST: Uss. (Maritime Territory: Voroshilov) (teliospores 28 — 33 (39) × 18 — 21 μ — f. dulcis (Otth ?), wall thickened, 2.5 — 4 μ, at the apex up to 5 μ).

On E. ferganensis B. Fedtsch. — CENTRAL ASIA: Pam.-Al. (Kirghiz SSR: near Osh in the Alai Range; near Dzhalal-Abada, in the Fergana Range) (teliospores 37 — 60 × 13 μ).

385 On E. squamosa Willd. (= **E. aspera** M. B., **E. muricata** M. B.) — CAUCASUS: Cisc., W Transc., S Transc. (teliospores 22.5 — 37 (40) × 7.5 — 17.5 μ — f. dulcis (Otth)).

On E. transoxana Prokh. — CENTRAL ASIA: Pam.-Al. (Kirghiz SSR: Gul'cha) (II).

On E. orientalis L. — CAUCASUS: W Transc. (f. helioscopiae (Pers.)).

On E. palustris L. — EUROPEAN PART: Lad.-Ilm., V.-Kama, Transv., V.-Don, L. Don, L. V. (teliospores 22.5 — 30 to 42.5 — 50 × 7.5 — 16 μ).

On E. semivillosa Prokh. — EUROPEAN PART: U. V., V.-Don, M. Dnp., Bl., L. Don, Transv. (f. dulcis (Otth)).

On E. songarica Boiss. — CENTRAL ASIA: Balkh. (Kazakh SSR: East Kazakhstan Region) (I — f. dulcis (Otth)).

On E. lamprocarpa Prokh. — CENTRAL ASIA: Pam.-Al. (Kirghiz SSR: Gul'cha), Balkh. (Kazakh SSR: Dzhambul), Tien Shan (Alma-Ata) (II (II, III) — f. dulcis (Otth)).

On E. pilosa L. (= E. lutescens C. A. M.) — W SIBERIA: Ob (Krasnoyarsk), Irt. (Biisk District), Alt. (Zmeino-Terskii District): E SIBERIA: Ang.-Say. (Minusinsk) (teliospores 28.5 — 37.5 × 7.5 — 15 μ — f. dulcis (Otth)).

On E. stricta L. — EUROPEAN PART: Crim.; CAUCASUS: Cisc., W Transc., E Transc. (everywhere only II — f. dulcis (Otth)).

On E. microsperma Boiss. — CENTRAL ASIA: Syr D. (Uzbek SSR: Tashkent) (teliospores 24 — 37.8 × 8 — 11 μ — f. dulcis (Otth)).

On E. alpina (C. A. M. — E SIBERIA: Lena-Kol. (Kirensk District), Ang.-Say. (Balagansk, Irkutsk, and Slyudyanka districts) (teliospores 20 — 37.5 × 7.5 — 15 μ — f. dulcis (Otth)).

On E. macrorrhiza C. A. M. — CENTRAL ASIA: Balkh., (Kazakh SSR: Zaisan District) (teliospores 37.8 — 48.6 × 8 — 13.5 μ, thickened at the apex).

On E. lucorum Rupr. — FAR EAST: Uss. (teliospores 30 — 32 × 12 — 15 μ, wall 1.5 μ thick — f. dulcis (Otth)).

On E. helioscopia L. — EUROPEAN PART: Lad.-Ilm., U. Dnp., Crim.; CAUCASUS: Cisc., W Transc., E Transc.; E SIBERIA: Ang.-Say. (Minusinsk) (f. helioscopiae (Pers.)).

On E. tranzschelii Prokh. — CENTRAL ASIA: Pam.-Al. (Kirghiz SSR) (teliospores 43 — 59 × 8 — 13 μ).

On E. alaica Prokh. — CENTRAL ASIA: Tien Shan (Kirghiz SSR: Chatkal Range) (teliospores $43-51 \times 8-11\,\mu$ — f. **dulcis** (Otth)).

On E. turkestanica Rgl. — CENTRAL ASIA: Syr D. (Uzbek SSR: Andizhan) (teliospores $43-54 \times 8-11\,\mu$).

On E. ispahanica Boiss. (= E. megalantha Boiss.) — CAUCASUS: E Transc. (Erevan) (f. **gerardianae** W. Müller).

On E. seguieriana Neck. — EUROPEAN PART: M. Dnp., V.-Don, Transv. Bl., L. Vol., Urals (Zlatoust); CAUCASUS: E Transc., S Transc.; W SIBERIA: Irt. (f. **gerardianae** W. Müller).

On E. humilis C. A. M. — CENTRAL ASIA: Balkh. (f. **gerardianae** W. Müller).

On E. kopetdaghi Prokh. (= E. fuchsii Bornm. et S.) — CENTRAL ASIA: Mtn. Turkm. (Turkmen SSR) (f. **gerardianae** W. Müller).

On E. macroclada Boiss. — CAUCASUS: E Transc. (Erevan) (f. **gerardi-**
386 **anae** W. Müller).

On E. glareosa Pall. — EUROPEAN PART: M. Dnp., V.-Don, Bl., L. Don, Crim. (f. **gerardianae**, W. Müller).

On E. myrsinites L. — EUROPEAN PART: Crim. (Yalta).

On E. marschalliana Boiss. — CAUCASUS: S Transc. (Armenian SSR).

On E. irgisensis Litw. — CENTRAL ASIA: Ar.-Casp. (Aktyubinsk Region: Kara-Chokat station) (I).

On E. esula L. — EUROPEAN PART: Dv.-Pech., V.-Kama, U. Dnp., L. Don, Transv.; W SIBERIA: Ob, U. Tob., Irt., Alt.; E SIBERIA: Lena-Kol., Ang.-Say., Dau.; FAR EAST: Uss.

On E. microcarpa Prokh. — W SIBERIA: Irt. (Lake Kuludinskoe) (f. **euphorbiae** (Cast.)).

On E. gracilis Bess. (= ? E. subtilis Prokh.) — EUROPEAN PART: V.-Don (Ryazan Region), L. Don (Saratov Region).

On E. latifolia C. A. M. — EUROPEAN PART: U. V. (Kineshma), V.-Kama (Kazan).

On E. agraria M. B. — EUROPEAN PART: (Odessa), Crim. (f. **euphorbiae** (Cast.)).

On E. mandshurica Max. — FAR EAST: Uss. (Maritime Territory) (f. **euphorbiae** (Cast.)).

On E. iberica Boiss. — EUROPEAN PART: L. Don (Saratov), Transv.; CAUCASUS: Cisc., E Transc., S Transc. (f. **euphorbiae** (Cast.)).

On E. uralensis Fisch. — EUROPEAN PART: L. V. (Stalingrad [Volgograd] Region); W SIBERIA: U. Tob., Irt. (Karaganda Region); CENTRAL ASIA: Ar.-Casp., Balkh. (f. **euphorbiae** (Cast.)).

On E. cyparissias L. — EUROPEAN PART: U. Dnp. (Kiev Region) (f. **euphorbiae** (Cast.)).

On E. cyrtophylla Prokh. — CENTRAL ASIA: Pam.-Al. (Tadzhik SSR: Gissar Range) (f. **euphorbiae** (Cast.)).

On E. leptocaula Boiss. — EUROPEAN PART: Bl. (Stalino Region; Kherson Region: Kherson, Askaniya-Nova), Crim. (f. **euphorbiae** (Cast.)).

On E. virgata Waldst. et Kit. — EUROPEAN PART: Lad.-Ilm., V.-Kama, U. Dnp., M. Dnp., V.-Don, L. Don, Transv.; E SIBERIA: Ang.-Say. (Minusinsk) (f. **euphorbiae** (Cast.)).

On E. boissieriana (Woron.) Prokh. (= E. virgata var. orientalis Boiss.) — CAUCASUS: E Transc. (Tbilisi, Shemakha, Nakhichevan), S Transc. (Erevan) (f. **euphorbiae** (Cast.)).

On E. jaxartica Prokh. — CENTRAL ASIA: Syr D. (Chimgan, Karnak on the Syr-Darya River) (f. **euphorbiae** (Cast.)).

On E. **subcordata** C. A. M. (=E. **caesia** Kar. et Kir.); W SIBERIA: U. Tob. (Kustanai) (f. **euphorbiae** (Cast.)).

On E. **oblongifolia** C. Koch (= E. rumicifolia Boiss.) — CAUCASUS: W Trans. (f. **dulcis** (Otth)).

On E. **macroceras** Fisch. et Mey. — CAUCASUS: W Transc. (Borzhoni) (f. **dulcis** (Otth)).

On E. **amygdaloides** L. — EUROPEAN PART: Crim.; CAUCASUS: W Transc., E Transc. (II — f. **dulcis** (Otth)).

On E. **polytimetica** Prokh. — CENTRAL ASIA: Pam.-Al. (Zeravshan Range).

On E. **graeca** Boiss. et Sprun. — EUROPEAN PART: Crim. (Planerskoe)
387 (f. **gerardianae** W. Müller).

On E. **peplis** L. — CAUCASUS: W Transc. (f. **euphorbiae** (Cast.)).

On E. **falcata** L. — EUROPEAN PART: L. Don, Crim.; CAUCASUS: W Transc., E Transc., S Transc.; CENTRAL ASIA: Pam.-Al., Syr D. (Osh) (f. **gerardianae** W. Müller).

On E. **francheti** B. Fedtsch.— CENTRAL ASIA: Pam.-Al. (Gul'cha) (f. **euphorbiae** (Cast.)).

On E. **turczaninowii** Kar. et Kir. — CENTRAL ASIA: Balkh., Kara K. (along the Murgab River), Amu D. (Farab).

On E. **lathyris** L. — CAUCASUS: W Transc. (Kutaisi) (II — f. **dulcis** (Otth)).

On E. **peplis** L. — EUROPEAN PART: Bl. (Odessa), Crim. (f. **euphorbiae** (Cast.)).

Experimental infections carried out by Müller, Klebahn, and other scientists revealed a relatively extensive specialization of the fungus.

33. M e l a m p s o r a g e l m i i Bresadola, Bull. Soc. bot. Ital. 1897, p. 75; Sacc., Sylloge, XIV, 1899, p. 288; Müller, Centrbl. Bacteriol. II. Abt., XIX, 1907, p. 546—547, fig. 1—3; Hariot, Uréd., 1908, p. 257; Trotter, Fl. Ital. Crypt. Ured., 1914, p. 395, fig. 100a; Syd., Monogr. Ured. III, 1915, p. 376, tab. XIV, fig. 351; Fragoso, Fl. Iber. Ured. II, 1925, p. 236, fig. 112; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 269.

Aecia unknown.

Uredia amphigenous, mainly hypophyllous, round, 0.5—1.0 mm wide, sometimes confluent, yellow. Urediospores globoid to ellipsoid, weakly echinulate, $15-25 \times 15-23\,\mu$. Paraphyses numerous, capitate.

Telia amphigenous, mostly hypophyllous, scattered, small, circular or oblong, frequently coalescing in rings, dark brown to black. Teliospores prismatic, usually slightly rounded at the apex, yellowish-brown or brown, $50-90 \times 8-12\,\mu$, according to our measurements $57.5-87.5 \times 7.5-12.5\,\mu$.

On **Euphorbia dendroides** L. and related species, in Spain, southern France, North Africa, and southern Iran.

On **Euphorbia rapulum** Kar. et Kir. — CENTRAL ASIA: Amu D. (Uzbek SSR, southern Kyzyl-Kum Desert, coll. P. N. Golovin).

34. Uredo (Melampsora?) hyperici-humifusi Kleb., Kryptogfl. M. Brandb. Va, 1914, S. 806, Fig. O21 (S. 812); Syd., Monogr. Ured. IV, 1924, p. 451; Sacc., Sylloge, XXIII, 1925, p. 936; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 278.

Uredia hypophyllous, round, slightly pulvinate, up to 0.5 mm, surrounded by remnants of torn epidermis resembling peridia, causing corresponding pale spots on the upper side of leaves. Urediospores solitary on pedicels, intermingled with paraphyses, ovoid, rarely globoid or ellipsoid, for the most part polyhedral, $18-21 \times 14-16\mu$; wall about 2μ thick, sparsely verrucose; warts at about 2μ intervals. Paraphyses $50-60\mu$ long, with colorless, smooth wall $3-5\mu$ thick; capitate, heads $18-22\mu$ wide,
388 pedicels $4-6\mu$ thick (from Klebahn, 1914, p. 806).

According to Klebahn the uredia of this fungus cannot be distinguished without microscopic examination from the caeomoid sori of **Melampsora hypericorum**. Uredia with paraphyses known only on **Hypericum humifusum** L. The affiliation to Melampsora is probable but not proved.

Klebahn revealed one location of **Uredo hyperici-humifusi** on **Hypericum humifusum** and several of **Melampsora hypericorum**. On **Hypericum humifusum** we found only **M. hypericorum**; it may be assumed that the host of **Uredo hyperici-humifusi** was some species of **Linum** or **Euphorbia**, but not **Hypericum humifusum**; only examination of the original specimen can help to elucidate the problem. If the host proves to be correctly determined, the fungus would have to be referred to **Melampsora kusanoi** Diet.

35. Melampsora hypericorum (DC) Schroet., Brand- u. Rostpilze Schlesiens, 1869, S. 26; Sacc., Sylloge, VII, 1888, S. 591; Fischer, Ured. Schweiz, 1904, S. 506, Fig. 317; Liro, Ured. Fenn., 1908, p. 559; Hariot, Uréd., 1908, S. 257; Migula, Kryptog.-Fl. Deutschl. III, 1, 1910, S. 486; Grove, Brit. Rust Fungi, 1913, p. 354, fig. 265; Klebahn, Kryptogfl. M. Brandb. Va, 1914, S. 804, Fig. O20 (S. 812); Trotter, Fl. Ital. Crypt. Ured., 1914, p. 399; Syd., Monogr. Ured. III, 1915, p. 384; Fragoso, Fl. Iber. Ured. II, 1925, p. 238, 383, fig. 114, 115; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 278.

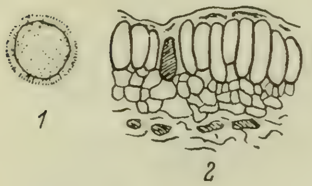


FIGURE 155. **Melampsora hypericorum** (DC) Schroet. on **Hypericum hirsutum** L.:

1 – aeciospores; 2 – teliospores. (After Klebahn)

Syn.: **Uredo hypericorum** DC, Mém. Soc. agric. Dép. Seine, X, 1807, p. 235; Fl. franç. VI, 1815, p. 81.

Pucciniastrum hypericorum Karst., Mycol. Fenn. IV, 1878, p. 56.

Mesospora hypericorum (DC) Diet., Ann. mycol. XX, 1922, p. 29–30.

Biol. Müller, Centrbl. Bacteriol. II. Abt., XVII, 5/7, 1907, S. 211; Klebahn, Ztschr. Pflanzenkr. XV, 2, 1905, S. 106, Fig. 4 (1, 4).

Spermagonia unknown.

Aecia hypophyllous, round, up to 0.5 mm across, surrounded by torn epidermis to which they remain attached by small, sterile cells of the

rudimentary peridia (Liro; Fragoso, Fig. 114). Aeciospores in short chains, without paraphyses, globoid, globoid-angular or ellipsoid, 16 — 23 × 14 — 19 μ (according to specimens from the USSR), with a thick, densely and rather coarsely verrucose wall.

Telia subepidermal, hypophyllous, small, round, reddish-brown, later dark brown. Teliospores prismatic, single-celled (exceptionally 2-celled, with a transverse septum in the lower third of the spore), with rounded ends, 20 — 30 × 10 — 16 μ; wall light brown, scarcely thickened at apex (Figure 155).

On species of **Hypericum**; autoecious.

General distribution: Europe, Asia (W Siberia, Far East ?). The reports about the distribution in India and the Far East are probably inaccurate (see **Chnoopsora sancti-johannis** and **Melampsora kusanoi**).

Cases in which several generations of caeomoid spores were produced per year while sometimes no spermagonia were discovered and the
389 characteristic structure of the aeciospore wall (in which coarse rods seem to be enclosed) led Dietel (l. c., pp. 29 — 30) to deny the aecial nature of the caeoma and refer this form of sporophore to the uredial stage; he compared the wall structure of the aeciospore with the urediospores of **Coleosporium** and **Chrysomyxa**; in Dietel's opinion the true aecia should be found on conifers. In accordance with these principles he removed the fungus to a new monotypic genus, **Mesospora**, with the species **Mesospora hypericorum**. The reasons given by Dietel proved insufficient. We know quite a few rust species in which, in the absence of urediospores, several generations are produced by repeating aecia; the absence of spermagonia may be explained by our failure to detect the primary sori, as the fungus probably overwinters in the caeomoid stage, and this problem will be clarified only by sowing teliospores. As to the wall structure, a similar structure is found in the aeciospores (and caeomoid spores) of all **Melampsoraceae**, including the genus **Melampsora**; the uredial stage of the genera **Chrysomyxa** and **Coleosporium** may actually be considered as derived from the aecial stage by the disappearance of peridia (according to Tranzschel, p. 278). Nevertheless, **Melampsora hypericorum** is definitely closely related to **Chnoopsora sancti-johannis** (Barcl.) Diet., having very similar aecia and teliospores; the main difference between these fungi is limited to the germination of the teliospore; in **Chnoopsora** germination immediately follows their production, whereas in **Melampsora hypericorum** it apparently requires a rest period.

Insofar as the fungus on **Hypericum calycinum** L. may be related to **Chnoopsora sancti-johannis**, a description of this species is given below (see p. 394).

Müller (l. c.) showed that **Melampsora hypericorum** includes a certain specialized form since aeciospores from **Hypericum montanum** infected only **H. montanum** (subspecies **M. hyperici-montani** W. Müller).

On **Hypericum androsaemum** L. — CAUCASUS: W Transc. (Krasnodar Territory: Adler; Georgian SSR: Zugdidi Valley; Adzhar ASSR: Batumi).

On **H. humifusum** L. — possibly occurs within the USSR. (The fungus is found in Bavaria.)

On **H. hirsutum** L. — EUROPEAN PART: V.-Kama (Krasnoufimsk), V.-Don (Penza; Kursk Region); W SIBERIA: Ob: Novosibirsk Region: Kolyvansoe.

On H. attenuatum Choisy. — W SIBERIA: Ang.-Say. (Minusinsk); FAR EAST: Uss. (Maritime Territory: Voroshilov).

On H. quadrangulum L. — EUROPEAN PART: Kar.-Lap. (Karelian ASSR: Petrozavodsk), Dv.-Pech. (Vologda Region: Kadnikov, Velikii Ustyug), Lad.-Ilm. (Leningrad Region; Kalinin Region: Kholm), U. V. (Yaroslavl'), V.-Kama (Krasnoufimsk; Tatar ASSR: Kazan), U. Dnp. (Smolensk Region, Dukhovshchina), U. Dns. (Drogobych Region: Stryi District).

On H. elegans Steph. — EUROPEAN PART: V.-Don (Voronezh), Transv. (Chkalov Region: Buguruslan), U. Dnp. (Kiev Region: Motovilovka near Kiev), Bl. (Kirovograd Region: Aleksandriya); CAUCASUS: Cisc. (Ordzhonikidze Territory: Aleksandrovskoe District); W SIBERIA: Irt. (Gryaznukha in Altai).

On H. montanum L. — EUROPEAN PART: U. Dnp. (Kiev Region: Motovilovka near Kiev), M. Dnp. (Belaya Tserkov; Chernigov Region: Priluki).

390 On H. perforatum L. — EUROPEAN PART: Dv.-Pech. (Arkhangel'sk Region: Kargopol'; Vologda Region: Velikii Ustyug), Lad.-Ilm. (Leningrad Region), Balt. (Latvian SSR), M. Dnp. (Uman), U. Dns. (Lvov Region), Bl. (Nikolaev Region: mouth of Dnieper); W SIBERIA: Irt. (Altai Territory: Rubtsovsk District).

On H. maculatum (?) — EUROPEAN PART: Balt. (Lithuanian SSR).

On H. montbretii Spach. — CAUCASUS: W Transc. (Georgian SSR, Abkhaz ASSR (Semashko)).

On H. erectum Thunb. — FAR EAST: Sakhalin (in the south, according to Hiratsuka) (apparently Melampsora kusanoi Diet.).

On H. calycinum L. (cult.) — EUROPEAN PART: Crim. (Alupka) (I; compare Chnoopsora sancti-johannis (Barcl.) Diet.).

36. Melampsora kusanoi Diet., Engler's Bot. Jahrb. XXXVIII, 1905, S. 104; Sacc., Sylloge, XXI, 1912, p. 601; Syd., Monogr. Ured. III, 1915, p. 386; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 278.

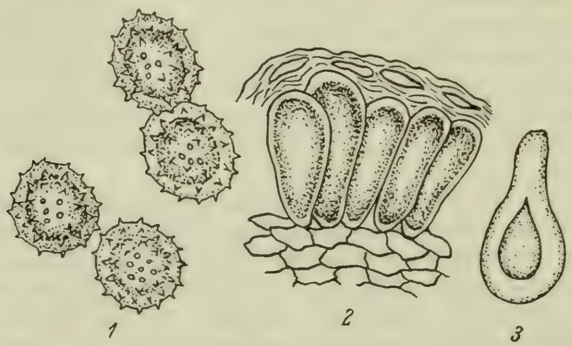


FIGURE 156. Melampsora kusanoi Diet. on Hypericum ascyron L.: 1 —urediospores; 2 — teliospores; 3 — paraphyses. ×600. (Orig.)

Spermagonia and aecia unknown.

Uredia hypophyllous, scattered, yellow. Urediospores globoid or broad-ellipsoid, $17-24 \times 15-18\,\mu$; wall colorless, echinulate, $1.5-2.0\,\mu$ thick. Paraphyses numerous, capitate, colorless, up to $70\,\mu$ long, at the apex $16-25\,\mu$ thick.

Telia hypophyllous, scattered or in irregular groups, subepidermal, small, 0.33 — 0.5 mm, chestnut-brown, later black. Teliospores prismatic, slightly thickened, light brown, darker at the apex, $22-32 \times 6-12\,\mu$ (Figure 156).

On species of Hypericum from the section Roscyna Spach. in eastern Asia.

On Hypericum ascyron L. — W SIBERIA: Irt. (Altai Territory: Troitskoe District); E SIBERIA: Ang.-Say. (Krasnoyarsk Territory, in the Sayan Mts.; Mt. Borus; Irkutsk Region: village of Kultuk); FAR EAST: Uss. (Khabarovsk; Maritime Territory: Vladivostok, Shkotovo District, Pos'etsk District, Voroshilov, village of Kamen-Rybolov).

On H. gebleri Ledb. — FAR EAST: Kamch. (Petropavlovsk in Kamchatka),
391 Sakh. (Sakhalin I.).

On H. paramushirense Kudo — FAR EAST: Sakh. (Kuril Is.).

On H. erectum Thunb. — FAR EAST: Sakh. (Sakhalin I. (?), see Melampsora hypericorum).

On Daphne (Thymelaeaceae)

37. Melampsora daphnicola (Diet.) Jørst., A Study on Kamchatka Uredinales, Skr. utg. av Det Norske Vid.-Akad. i Oslo I Matem.-Naturvid. Klasse, 1933, 9, 1934, S. 55; Tranzschel, Consp. Ured URSS, Moscow, 1939, p. 283.

Syn.: Uredo daphnicola Diet., Hedwigia, XXVII, 1898, S. 213; Sacc., Sylloge, XIV, 1899, p. 400; Syd., Monogr. Ured. IV, 1924, p. 445.

Spermagonia and aecia unknown.

Uredia hypophyllous, scattered, round, up to 15 mm across (according to Sydow, 0.2 — 0.3 mm) surrounded by remnants of the torn epidermis.

Urediospores globoid, ellipsoid, or ovoid, $18-26 \times 15-21\,\mu$; wall colorless, finely echinulate, $1.5-2.5\,\mu$ thick. Paraphyses numerous, up to $100\,\mu$ long, capitate; pedicels $5-8\,\mu$ wide, head width $20-30\,\mu$, head wall $2-7\,\mu$ thick.

Teliospores unknown.

On Daphne kamtschatica in Kamchatka and (on D. odora ?) in China. On representatives of family Thymelaeaceae is described, apart from M. daphnicola (Diet.) Jorst. and M. stellerae Teich, even M. yoshinagai Hemings (Hedwigia, XLII, 1903, S. 108; Sydow, Monogr. Ured., III, 1915, p. 391), on species of Wikstroemia in Japan, Formosa, and India; for this species Hiratsuka found and described the aecial stage on Wikstroemia gampi Maxim. It is possible that M. yoshinagai and M. stellerae are identical with M. daphnicola.

On Daphne kamtschatica Maxim. — FAR EAST: Kamch. (Middle Opal'naya River (S Kamchatka) and Klyuchi (central Kamchatka)).

On Daphne jezoensis Maxim. — FAR EAST: Sakh. (Kuril Is. (according to Hiratsuka)).

38. Melampsora stellerae Teich, Byull. Sr.-Az. Gos. univ., 19, 24, 1934, p. 181, fig. 2, 3; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 283.

Spermagonia and aecia unknown.

Uredia mostly hypophyllous, rarely epiphyllous, scattered or in groups, small, 0.25 — 1.0 mm across, yellow. Urediospores globoid, ovoid, or ellipsoid, 13 — 23 × 10 — 16 μ; wall colorless, echinulate, 2 — 2.5 μ thick. Paraphyses numerous, capitate, colorless, 39 — 69 μ long, at the apex 9 — 20 μ thick.

(392)

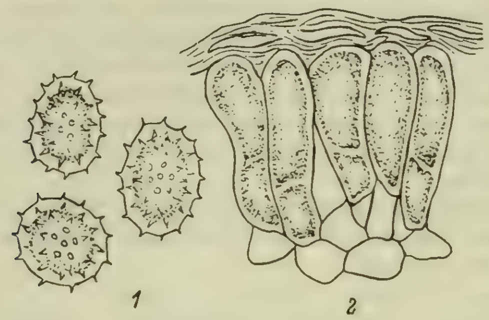


FIGURE 157. Melampsora stellerae Teich on Stellera alberti Reg.:

1 — urediospores; 2 — teliospores. × 600. (Orig.)

Telia mainly hypophyllous, rarely epiphyllous, scattered or confluent in groups, subepidermal, small, 0.16 — 0.5 mm across, yellowish-brown, later dark brown. Teliospores prismatic, rounded at the apex, slightly thickened, 25 — 50 × 4.6 — 11.5 μ, for the most part single-celled, always transverse or diagonally septate; wall 1 μ thick (Figure 157).

On species of Stellera in Central Asia and eastern Siberia. See
392 Melampsora daphnicola (Diet.) Jørst.

On Stellera alberti (Reg.) Pobed. — CENTRAL ASIA: Tien Shan (Kazakh SSR: Chimgan (W Tien Shan)), Pam.-Al. (Turkmen SSR: Kugitang Range).

On Stellera chamaejasme L. — E SIBERIA: Dau. (Buryat-Mongol ASSR: Kyakhta, village of Etetei (former Verkhneudinsk (county)).

On Apocynum (Apocynaceae)

39. Melampsora apocyni Tranz., Bot. zap. Bot. sada SPb. univ. (Scripta bot. Horti Univ. Petrop.) III, 2 (=No. VII), 1891, p. 138; ditto Isachenko, V, 2 (= No. XII), 1896, p. 237; Sacc., Sylloge, XI, 1895, p. 183; XIV, 1899, p. 288; Syd., Monogr. Ured. III, 1915, p. 389; Tranzschel, Rzhavchina kendyrya, Zashch. rast., VIII, 1931, p. 531; Consp. Ured. URSS, 1939, p. 52, 320.

Spermagonia and aecia unknown.

Uredia hypophyllous scattered or gregarious, round, small, 0.2 — 0.4 mm across, erumpent, orange-yellow, surrounded by the torn epidermis. Urediospores globoid or broad-ellipsoid, 17 — 25 × 16 — 20; wall 3.0 — 3.5 μ thick, colorless, densely blunt-verrucose. Paraphyses numerous, colorless, 35 — 48 μ long, at the capitate swelled apex 18 — 25 μ across; wall 3 — 5 μ thick.

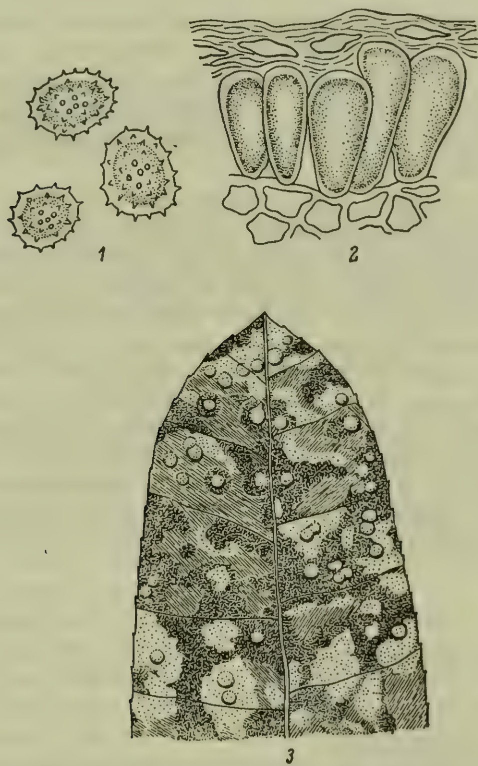


FIGURE 158. Melampsora apocyni Tranz. on Apocynum venetum L.:

1 — urediospores, × 525; 2 — teliospores, × 525; 3 — leaf of Apocynum with sori, × 4.4. (Orig.)

Telia hypophyllous, subepidermal, small, 0.2 — 0.5 mm across, usually coalescing in irregular groups, reddish-brown, later black-brown.
393 Teliospores prismatic, as a rule rounded at the apex, tapering below, 35 — 42 × 7 — 13 μ; wall light brown, 1 μ thick (Figure 158).

On Apocynum venetum in the southern USSR and in Central Asia, also in Iran and Turkey.

On Apocynum venetum L. (s. l.) — EUROPEAN PART: Bl. (Nikolaev, Dzharylgach I.), L. V., (Stalingrad Region: Gandurino); CAUCASUS: W Transc. (Krasnodar Territory: Temryuk), Dag. (Dagestan ASSR: Derbent, Kizlyar); E Transc. (Azerbaijan SSR: Geokchai); CENTRAL

ASIA: Kara K. (Turkmen SSR: Geok-Tepe, Ioltan, Chardzhou (widespread)), Ar.-Casp. (Kazakh SSR: Kzyl-Orda (widespread)), Balkh. (Alma-Ata Region: Chilik District, etc.), Syr. D. (Uzbek SSR: Chirchik River near Tashkent; Tadzhik SSR: Leningrad; Stalinabad [Dushanbe]), Tien Shan (Kirghiz SSR: near the city of Frunze, Chu River floodplain).

SPECIES SUBJECT TO REJECTION

Melampsora cynanchi Thüm., Bull. Soc. nat. Moscou, LII, 1, 1877, p. 140; Mycotheca univers. No. 1136, 1878; Sacc., Sylloge, VII, 1888, p. 591; Syd., Monogr. Ured. III, 1915, p. 389; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 321.

This species, collected only by Martyanov in 1876, on the solonetz-sandy sites near Minusinsk (Krasnoyarsk Territory), proved to be inaccurately described. A comparison of the original specimens published by Thümen (Mycotheca universalis No. 1136) and of the two original specimens collected by Martyanov in Minusinsk — No. 55 — with specimens of Antitoxicum sibiricum (L.) Pobed. (family Asclepiadaceae) showed that Cynanchum sibiricum is not a host of M. cynanchi. The leaves of C. sibiricum have needlelike fine hairs at their margins and along the midrib, whereas the host of M. cynanchi has smooth leaves with cartilaginous borders, the same as Euphorbia sp. with Melampsora euphorbiae Cast. in the Martyanov collection. For lack of flowering buds it is impossible to determine the exact species of Euphorbia on which "Melampsora cynanchi" was collected; most probably it was Euphorbia esula L.

18. Genus CHNOOPSORA Diet.

Diet., Ann. mycol. IV, 1906, p. 423.

Spermagonia subepidermal.

Aecia without peridia, caeomoid, orange-colored, later fading. Aeciospores catenulate, globoid, elongate, verrucose. Urediospores absent.

Telia subepidermal, later erumpent in one-layered scabs, small at first, gradually coalescing and occasionally covering extensive areas. Teliospores prismatic, single-celled, sometimes dividing diagonally or transversally into 2 cells, crowded in groups, germinating as soon as mature; wall almost colorless, smooth.

There are 4 known species, including one in theFar East, 2 in India, and one in central Africa.

394 Key to Species of Chnoopsora

I. Teliospores $25-44 \times 6-10\mu$; the fungus produces aecia. On species of Hypericum (in India) . . . . 1. Chnoopsora sancti-johannis (Barcl.) Diet.

II. Teliospores $27-38 \times 9-15\mu$; aecia absent. On Oxalis (Far East) . . . . 2. Chnoopsora itoana Hirats.

On Guttiferae

1. **Chnoopsora sancti-johannis** (Barcl.) Diet., Ann. mycol. IV, 1906, p. 422; Syd., Monogr. Ured. III, 1815, p. 397; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 278.

Syn.: **Melampsora sancti-Johannis** Barcl., Descr. List Ured. Simla, III, p. 84, in Journ. Asiat. Soc. Bengal, LIX, pt. II, 2, 1890; Sacc., Sylloge, IX, 1891, p. 296.

Spermagonia mostly epiphyllous, flat, $250-345\,\mu$ wide, $126-144\,\mu$ high.

Aecia (caeomoid) amphigenous, more frequently hypophyllous, scattered or in irregular groups, round or elongate, surrounded by torn epidermis, pale orange-colored, without paraphyses. Aeciospores in short chains, varying in shape, globoid, ovoid, or pyriform, often angular, $12-28 \times 11-22\,\mu$ (mostly $20-26 \times 15-21\,\mu$); wall colorless, densely verrucose, $2.5-3.5\,\mu$ thick.

Telia hypophyllous, at first small, in groups, later confluent in crusts up to 1 cm long, pale yellow, later brown. Teliospores germinate into basidia without a rest period, single-celled, occasionally 2-celled, prismatic or cylindroid-prismatic, almost colorless, $25-44 \times 6-10\,\mu$; wall $1.0-1.5\,\mu$ thick.

On **Hypericum cernuum** Roxb., **H. patulum** Thunb., **H.** (?) elodeoides, in India. Not found in the USSR (see below).

Infection of the plants in India proceeds in two ways. For the most part systematic infections involve entire shoots arising from the axils of normal leaves; these shoots stop growing and bear smaller leaves, or more rarely, display sori scattered on normal leaves. In the Herbarium of the Botanical Institute of AN SSSR are found specimens of both kinds of infection (Sidow, Ured. 2491). According to Barclay the aecial stage is unusual and not evident in India.

C. sancti-johannis (Barcl.) Diet. is certainly closely related to **Melampsora hypericorum** (DC) Schroet. According to Dietel, **Chnoopsora** is distinguished from **Melampsora** in that the teliospores do not mature simultaneously in the sori; the younger teliospores grow in the midst of the earlier-formed ones. This is an ecological feature, since development of the younger spores is correlated with the germination of the older ones, situated above. The primary differential characteristic of the genus **Chnoopsora** remains the germination of teliospores without a rest period.

On **Hypericum calycinum** L. (place of origin — European and Asiatic Turkey) bred in the Alupkinskii Park in the Crimea. V. G. Tranzschel collected caeomas of the fungus and referred them to **Melampsora hypericorum**. The normal-sized leaves of this specimen are densely covered with sori on yellowed patches. On the inner side of the epidermis small, isodiametric, angular cells of the rudimentary peridia are quite
395 evident (as in **Melampsora hypericorum**). The spores are very similar to the aeciospores of **M. hypericorum**. Tranzschel maintained that the fungus he collected from **Hypericum calycinum** is probably related to **Chnoopsora sancti-johannis**, which under the influence of adverse climate had lost the property of producing teliospores and evolved the more intensive development of the aecial stage. No further examinations of the fungus on **H. calycinum** have been conducted (see **Melampsora hypericorum** (DC) Schroet.).

On Oxalidaceae

2. **Chnoopsora itoana** Hirats., Japan. Journ. Botany, III, 4, 1927, p. 297; Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 262.

Telia hypophyllous, subepidermal, at first very small, later coalescing in crustlike groups up to 2 — 6 mm wide, initially muddy-brown, later fading, causing disintegration of the tissue attacked which is often subsequently shed. Teliospores cylindroid or digitate, pale yellow, smooth, $27-38 \times 9-15\,\mu$, germinate immediately after maturation; wall about $1\,\mu$ thick, without apical thickening (Figure 159).

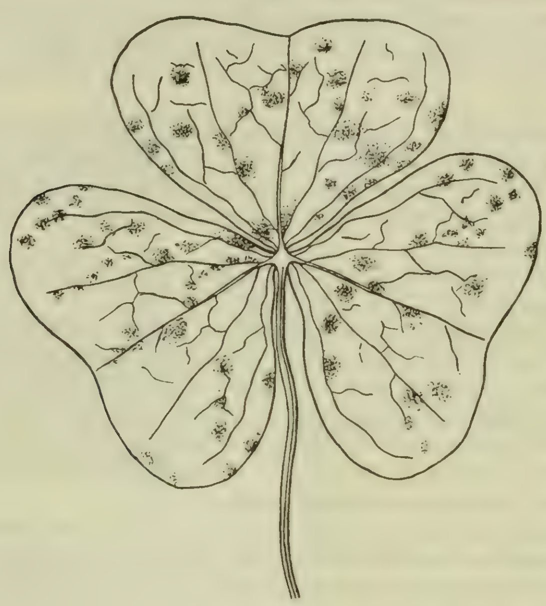


FIGURE 159. **Chnoopsora itoana** Hirats. Telia on **Oxalis acetosella** L. ×4. (Orig.)

On **Oxalis acetosella**. According to Hiratsuka the fungus is distinguished from **Chnoopsora sancti-johannis** by the shape of spores and the absence of aecia and from **C. butteri** Diet. et Syd. and **C. rigida** (Har. et Pat.) Syd. by the smaller spore size and color of telia.

On **Oxalis acetosella** L. — FAR EAST: Uss. (Maritime Territory), Sakh. (often in S Sakhalin).

396 19. Genus APLOSPORA Mains

Mains, Amer. Journ. Botany, VIII, 1921, p. 442, fig. 1, 2, 3 (p. 443 —444).

Uredio- and teliospores known. Urediospores are produced single, verrucose; pores inconspicuous.

Telia lenticular, starting under the epidermis, soon erumpent and sprouting, acquiring an ash-gray color. Teliospores single-celled, cylindroid, in one layer, colorless, with thin, smooth walls.

Distinguished from Melampsora by the colorless teliospores and by germination immediately upon maturation; very close to Melampsora, Chnoopsora, and Melampsoridium.

Two species are known, one in North America, the other in the USSR and China.

On Lonicera (Caprifoliaceae)

1. Aplospora lonicerae Tranz., Tranzschel, Consp. Ured. URSS, Moscow, 1939, p. 347.

Spermagonia and aecia unknown.

Uredia hypophyllous, small, densely surrounded by paraphyses; paraphyses thick-walled, initially colorless, later brownish, united at the basis, clavate or cylindrical. Urediospores (we have seen very few) globoid to broad-ellipsoid, echinulate, colorless, $21.6-29.7 \times 16.2-21.6\,\mu$; pores inconspicuous.

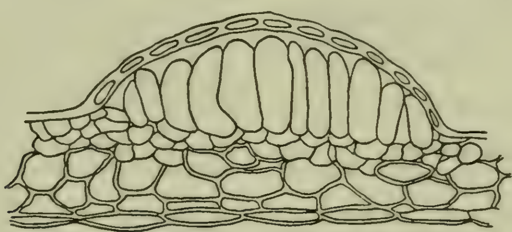


FIGURE 160. Aplospora lonicerae Tranz. Section through telium (after Tranzschel, 1939)

Telia hypophyllous, covered by epidermis, small, waxy, yellowish when dry. Teliospores unicelled, prismatic, rounded at apex, without pedicels, germinating as soon as mature (Figure 160).

The fungus closely resembles Aplospora nyssae (Ellis et Tracy) Mains (Arthur, Manual Rusts U. S. A. a. Canada, 1934, p. 59, Fig. 87) and Cerotelium dicentrae Mains et Anderson (Arthur, l. c., p. 61, Fig. 90). It may be assumed that Aecidium corydalinum Syd., from Japan, is related to these fungi.

On Lonicera maximowiczii (Rupr.) Max. — FAR EAST: Sutar River (tributary of the Bol'shaya Bira River); also on Lonicera coerulea L. (incl. L. altaica Pall. et L. edulis Turcz.), Manchuria, Ichesunkhe Valley.

ALPHABETICAL INDEX OF LATIN NAMES OF FUNGI

Note: Names of fungi printed in italics denote synonyms. Page numbers in bold type indicate main entries.

[*] [This index has been reproduced photographically from the Russian original.]

[**] [Russian page numbers appear in the left-hand margin of the text.]

5564

ALPHABETICAL INDEX OF LATIN NAMES OF HOSTS[1]

[Note. This index has been reproduced photographically from the Russian original. Numbers in this index refer to pages of the Russian original, which appear in the left-hand margin of this translation.]

[1] The names of host plants are rendered in many cases in transliteration of the herbarium labels. Those in the collections of rust fungi of W. Tranzschel, F. Buchholtz, T. Westergren, A. Yaczewski, N. Naoumoff, and other mycologists were determined by the authors and botanists-taxonomists such as V. L. Komarov, N. I. Kuznetsov, B. A. Fedchenko and D. P. Syreishchikov. Various Keys and Floras in Russian, German and French were used. We endeavoured to present in this volume the names of plants according to the nomenclature used in the USSR. Our success was only partial due to the absence of comprehensive lists of synonyms of species of the USSR Flora and to the incompleteness of this volume. For these and some other reasons we abandoned the complete revision of names of host plants indicated on the herbarium labels. Correction of plant names on labels or the redetermination of host plants on the basis of very limited material is inadmissible and could lead to grave errors.

Page numbers in semi-bold type refer to sub-titles on host plants.

FLORA REGIONS OF THE USSR

Abbreviated name	Full name
I. Arctic	
1. Arc. Eur.	Arctic (European part)
2. Nov. Z.	Novaya Zemlya
3. Arc. Sib.	Arctic (Siberia)
4. Chuk.	Chukchi
5. An.	Anadyr
II. European part	
6. Kar.-Lap.	Karelia-Lapland
7. Dv.-Pech.	Dvina-Pechora
8. Balt.	Baltic States
9. Lad.-Ilm.	Ladoga-Il'men
10. U. V.	Upper Volga
11. V.-Kama	Volga-Kama
12. U. Dnp.	Upper Dnieper
13. M. D.	Middle Dnieper
14. V.-Don	Volga-Don
15. Transv.	Transvolga area
16. U. Dns.	Upper Dniester
17. Bes.	Bessarabia
18. Bl.	Black Sea area
19. Crim.	Crimea
20. L. Don	Lower Don
21. L. V.	Lower Volga
III. Caucasus	
22. Cisc.	Ciscaucasia
23. Dag.	Dagestan
24. W. Transc.	Western Transcaucasia
25. E. Transc.	Eastern Transcaucasia
26. S. Transc.	Southern Transcaucasia
27. Tal.	Talysh
IV. West Siberia	
28. Ob	Ob region (from the eastern slopes of the Urals to the Yenisei River)
29. U. Tob.	Upper Tobol
30. Irt.	Irtysh
31. Alt.	Altai

V. East Siberia

32. Yenis.	Yenisei
33. Lena-Kol.	Lena-Kolyma
34. Ang.-Say.	Angara River-Sayans
35. Dau.	Dauria

VI. Far East

36. Kamch.	Kamchatka
37. Okh.	Okhotsk
38. Ze.-Bu.	Zeya-Bureya
39. Uda	Uda River area
40. Uss.	Ussuri
41. Sakh.	Sakhalin

VII. Soviet Central Asia

42. Ar.-Casp.	Aral-Caspian
43. Balkh.	Lake Balkhash area
44. Dzu-Tarb.	Dzungaria-Tarbagatai
45. Kyz. K.	Kyzyl-Kum
46. Kara K.	Kara-Kum
47. Mtn. Turkm.	Mountainous part of Turkmenistan
48. Amu D.	Amu Darya
49. Syr D.	Syr Darya
50. Pam.-Al.	Pamir-Alai
51. T. Sh.	Tien Shan

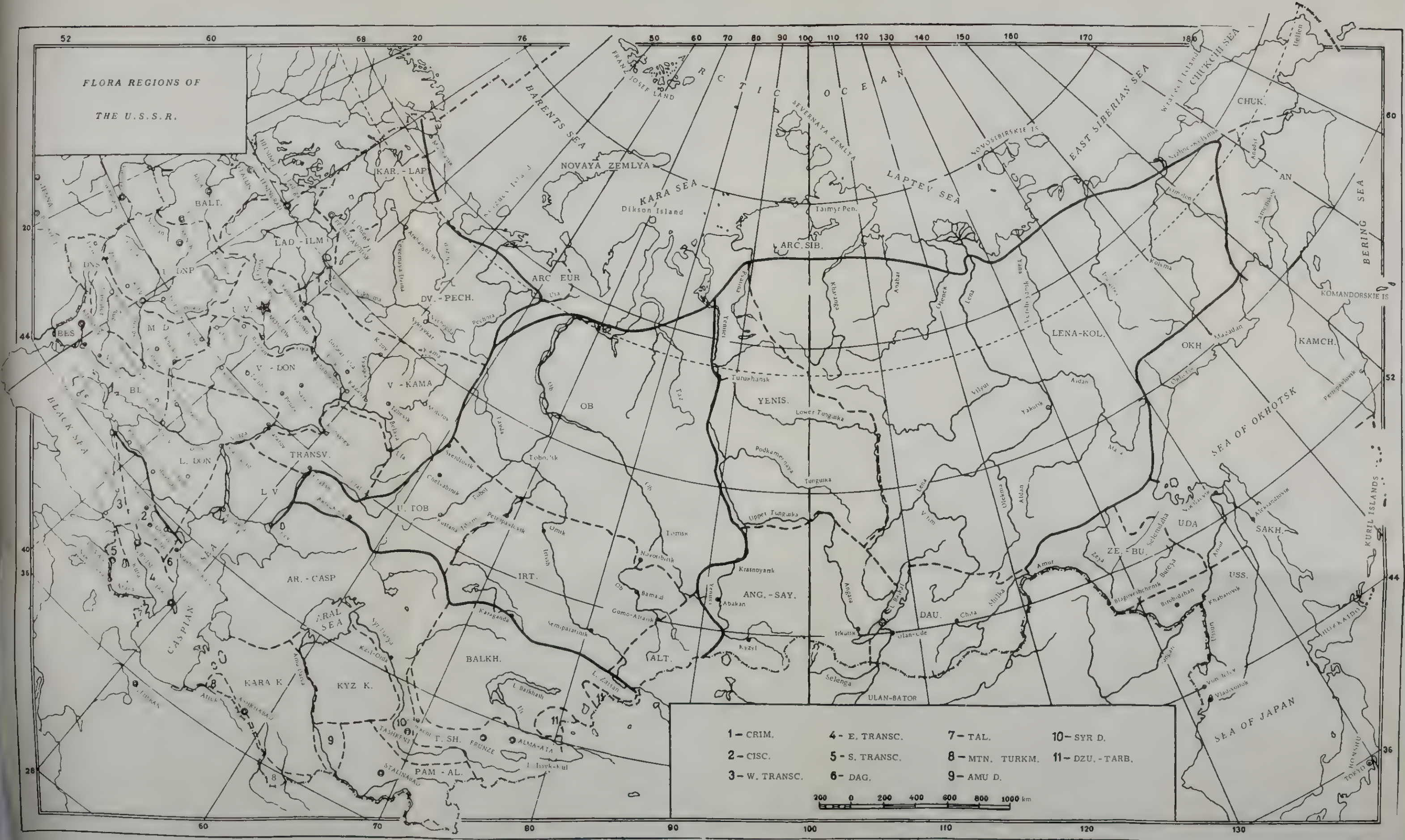
Other Geographical Abbreviations

Afr.	Africa
Aust.	Australia
Centr.	Central
E.	East(ern)
Gr.	Great, Greater
I.	Island
Is.	Islands
Mt.	Mount
Mts.	Mountains
N.	North(ern)
R.	River
S.	South(ern)
W.	West(ern)

Translation Editor's Note

1. The Russian term "Srednyaya Aziya" is, in English, Central Asia (or Soviet Central Asia). Therefore the term Middle Asia has been used for Russian "Tsentral'naya Aziya," which is non-Soviet inner Asia, comprising western China (Sinkiang and Tibet) and Mongolia.

2. According to Russian usage, the European part of the USSR is "eastern Europe." Therefore "western Europe" includes the whole of Europe outside the USSR.


FLORA REGIONS OF
THE U.S.S.R.
1 – CRIM.
2 – CISC.
3 – W. TRANSC.
4 – E. TRANSC.
5 – S. TRANSC.
6 – DAG.
7 – TAL.
8 – MTN. TURKM.
9 – AMU D.
10 – SYR D.
11 – DZU.-TARB.
200 0 200 400 600 800 1000 km
ARCTIC OCEAN
BARENTS SEA
KARA SEA
LAPTEV SEA
EAST SIBERIAN SEA
CHUKCHI SEA
BERING SEA
SEA OF OKHOTSK
SEA OF JAPAN
BLACK SEA
CASPIAN SEA
ARAL SEA
KURIL ISLANDS
NOVAYA ZEMLYA
FRANZ JOSEF LAND
SEVERNAYA ZEMLYA
NOVOSIBIRSKIE IS.
KOMANDORSKIE IS.
KAR.-LAP.
BALT.
LAD.-ILM.
ARC. EUR.
DV.-PECH.
ARC. SIB.
V.-KAMA
V.-DON
L. DON
TRANSV.
L. V.
U. TOB.
AR.-CASP.
OB
IRT.
YENIS.
ANG.-SAY.
ALT.
BALKH.
KARA K.
KYZ. K.
T. SH.
PAM.-AL.
LENA-KOL.
OKH.
KAMCH.
CHUK.
AN.
UDA
SAKH.
ZE.-BU.
USS.
DAU.
BES.
BL.
ULAN-BATOR

LIST OF ABBREVIATIONS OF AUTHORS' NAMES APPEARING IN THIS BOOK*

A. Br.	— A. Braun
Alb.	— Albertini
Arth.	— Arthur
Barcl.	— Barclay
Bon.	— Bonorden
Brond.	— Brondeau
Buch.	— Buchholtz
Butl.	— Butler
C.	— Curtis
Cast.	— Castagne
Clint.	— Clinton
Cumm.	— Cummins
D. et H.	— Dietel et Holway
DC	— De-Candolle
Desmaz.	— Desmazières
De-T.	— De-Toni
Diet.	— Dietel
Dietr.	— Dietrich
Ed. Fisch.	— Ed. Fischer
Ehrenb.	— Ehrenberg
Gall.	— Galloway
Gmel.	— Gmelin
Hedgc.	— Hedgcock
Henn.	— Hennings
Hirats.	— Hiratsuka
Holw.	— Holway
Jacz.	— Jaczewski
Jørst.	— Jørstad
Karst.	— Karsten
Kleb.	— Klebahn
Kom.	— Komarov
Körn.	— Körnicke
Kze.	— Kuntze
Kupr.	— Kuprewicz
L.	— Linnaeus
Lagerh.	— Lagerheim
Lév.	— Léveillé
Lindr.	— Lindroth
Magn.	— Magnus
Mart.	— Martius
Mats.	— Matsumoto
Moug.	— Mougeot
Namysl.	— Namyslowski
A. Naum.	— Naumann
Naum.	— Naumov
Nestl.	— Nestler
Orish.	— Orischimo
Oud.	— Oudemans
P. Cruch.	— P. Cruchet
Pass.	— Passerini
Pers.	— Persoon
Plowr.	— Plowright
Rabenh.	— Rabenhorst
Ranojev.	— Ranojevitch
Rebent.	— Rebentish
Rostr.	— Rostrup
Sacc.	— Saccardo
Schl.	— Schlechtendal
Schm.	— Schmidt
Schroet.	— Schroeter
Schub.	— Schubert
Schum.	— Schumacher
Schw.	— Schweinitz
Speg.	— Spegazzini
Syd.	— Sydow
Thüm.	— Thümen
Tranz.	— Tranzschel
Trott.	— Trotter
Tub	— Tubeuf
Tul.	— Tulasne
Underw.	— Underwood
Wagn.	— Wagner
Wallr.	— Wallroth
West.	— Westendorp
Willd.	— Willdenow
Wróbl.	— Wróblevski

* [See Translator's Note on p. v.]

EXPLANATORY LIST OF ABBREVIATED NAMES OF USSR INSTITUTIONS, PERIODICALS, ETC., APPEARING IN THIS TEXT

Abbreviation	Full name (transliterated)	Translation
AN Arm. SSR	Akademiya Nauk Armyanskoi SSR	Academy of Sciences of the Armenian SSR
AN Gruz. SSR	Akademiya Nauk Gruzinskoi SSR	Academy of Sciences of the Georgian SSR
AN SSSR	Akademiya Nauk SSSR	Academy of Sciences of the USSR
AN UkrSSR	Akademiya Nauk Ukrainskoi SSR	Academy of Sciences of the Ukrainian SSR
Bot. mater. Otd. spor. rast. Bot. Inst. AN SSSR	Botanicheskie materialy otdeleniya sporovykh rastenii Botanicheskogo Instituta Akademii Nauk SSSR	Botanical Studies of the Department of Spore Plants, Botanical Institute, Academy of Sciences of the USSR
Bot. zap. izdav. Bot. sad. SPb. univ.	Botanicheskie zapiski, izdavaemye pri botanicheskom sade Imperatorskogo Sankt-Peterburgskogo universiteta	Botanical Reports Published by the Botanical Garden of the Imperial St. Petersburg University
Byull. Mosk. obshch. ispyt. prir., Otd. biol.	Byulleten' Moskovskogo obshchestva ispytatelei prirody. Otdel Biologicheskii	Bulletin of the Naturalists' Society of Moscow (Biological Section)
Byull. sess. VASKHNIL	Byulleten' sessii Vsesoyuznoi akademii sel'skokhozyaistvennykh nauk im. V. I. Lenina	Bulletin of the Session of the V. I. Lenin All-Union Academy of Agricultural Sciences
Byull. Sr.-Az. Gos. univ.	Byulleten' Sredneaziatskogo Gosudarstvennogo universiteta	Central Asian State University
Izv. AN Arm. SSR	Izvestiya Akademii Nauk Armyanskoi SSR	Bulletin of the Academy of Sciences of the USSR
Izv. Ivanovo-Voznesensk. Politekh. Inst.	Izvestiya Ivanovo-Voznesenskogo politekhnicheskogo instituta	Bulletin of the Ivanovo-Voznesensk Polytechnical Institute
Izv. Kazansk. Inst. Sel'sk. Khoz. Lesov.	Izvestiya Kazanskogo instituta Sel'skogo Khozyaistva i Lesovodstva	Bulletin of the Kazan Institute of Agriculture and Forestry
Izv. Leningr. lesn. inst.	Izvestiya Leningradskogo lesnogo instituta	Bulletin of the Leningrad Forestry Institute

Izv. Tomsk. univ.	Izvestiya Tomskogo universiteta	Bulletin of the Tomsk University
Izv. i Trudy C.-Kh. Otd. Rizhsk. Politekh. Inst.	Izvestiya i trudy sel'skokhozyaistvennogo otdeleniya Rizhskogo politekhnicheskogo instituta	Bulletin and Transactions of the Department of Agriculture of the Riga Polytechnical Institute
Kratkii otchet n.-issled. rabot. oblasti zashch. urozhaya s.-kh. kul't. Primorsk. kraya	Kratkii otchet o nauchno-issledovatel'skikh rabotakh v oblasti zashchity urozhaya sel'skokhozyaistvennykh kul'tur Primorskogo kraya	A Brief Report on Scientific Research Work on the Protection of Agricultural Crops in the Maritime Territory
Lesn. fitopatol.	Lesnaya fitopatologiya	Forest Phytopathology
Listok dlya bor'by s bol. i povrezhd. kul't. i dikorast. polezn. rast.	Listok dlya bor'by s boleznyami i povrezhdeniyami kul'turnykh i dikorastushchikh poleznykh rastenii	A Guide to the Control of Diseases and Damage to Cultivated and Wild-Growing Beneficial Plants
Mater. po mikol. i fitopatol.	Materialy po mikologii i fitopatologii	Materials on Mycology and Phytopathology.
NKZ Armenii	Narodnyi Komissariat Zemledeliya Armenii	People's Commissariat of Agriculture of Armenia
OZRA	Otdel Zashchity Rastenii	Department of Plant Protection
Protok. zased.	Protokoly zasedanii	Proceedings
Sel. i semenov.	Selektsiya i semenovodstvo	Breeding and Seed Growing
Sel'sk. Khoz. i Lesov.	Sel'skoe Khozyaistvo i Lesovodstvo	Agriculture and Forestry
Soobshch. Dal'nevost. Fil. AN SSSR	Soobshcheniya Dal'nevostochnogo Filiala Akademii Nauk SSSR	Communications of the Far Eastern Branch of the Academy of Sciences of the USSR
Sots. Sel'sk. Khoz. Uzbekistana	Sotsialiticheskoe Sel'skoe Khozyaistvo Uzbekistana	Socialist Agriculture of Uzbekistan
STAZRA	Stantsiya Zashchity Rastenii	Plant Protection Station
Tr. Bot. inst. AN SSSR	Trudy Botanicheskogo instituta Akademii Nauk SSSR	Transactions of the Botanical Institute of the Academy of Sciences of the USSR
Tr. Bot. muzeya Akad. Nauk	Trudy Botanicheskogo muzeya Akademii Nauk	Transactions of the Botanical Museum of the Academy of Sciences
Tr. Sib. inst. sel'sk. khoz. i lesov.	Trudy Sibirskogo Instituta Sel'skogo Khozyaistva i Lesovodstva	Transactions of the Siberian Institute of Agriculture and Forestry

Tr. SPb. obshch. estestv., Otd.	Trudy Sankt-Peterburgskogo obshchestva estestvoispytatelei. Otdel botanicheskii	Transactions of St. Petersburg Naturalists' Society (Botanical Section)
Tr. Tifl. bot. sada	Trudy Tiflisskogo botanicheskogo sada	Transactions of Tiflis Botanical Garden
Trudy Gor'kovsk. Sel'sk. Khoz. Inst.	Trudy Gor'kovskogo Sel'skokhozyaistvennogo Instituta	Transactions of the Gorki Agricultural Institute
Trudy Gos. Nikitsk. Bot. Sada	Trudy Gosudarstvennogo Nikitskogo Botanicheskogo Sada	Transactions of the State Nikitskii Botanical Garden
Trudy Inst. Gen. i Selektsii AN URSR	Trudy Instituta Genetiki i Selektsii Akademii Nauk Ukrayins'ka Radyans'ka Sotsialistychna Respublika	Transactions of the Institute of Genetics and Selection of the Academy of Sciences of the Ukrainian SSR
Trudy po Lekarstv. i Aromat. Rast.	Trudy po Lekarstvennym i Aromaticheskim Rasteniyam	Transactions of Medicinal and Aromatic Plants
Trudy Sochinsk. Op. St. Subtrop. i Yuzhn. Plod. Kul'tur	Trudy Sochinskoi Opytnoi Stantsii Subtropicheskikh i Yuzhnykh Plodovykh Kul'tur	Transactions of the Sochi Experimental Station of Subtropical and Southern Fruit Crops
VASKHNIL	Vsesoyuznaya Akademiya Sel'skokhozyaistvennykh Nauk imeni V. I. Lenina	V. I. Lenin All-Union Academy of Agricultural Sciences
VIPBiNK	Vsesoyuznyi Institut Prikladnoi Botaniki i Novykh Kul'tur	All-Union Institute of Applied Botany and New Cultures
VIZR	Vsesoyuznyi Institut Zashchity Rastenii	All-Union Institute of Plant Protection
VNIIKH	Vsesoyuznyi Nauchno-Issledovatel'skii Institut Khlopkovodstva	All-Union Scientific Research Institute for Cotton Growing
VNITOLES	Vsesoyuznoe Nauchnoe Inzherno-Tekhnicheskoe Obshchestvo Lesnoi Promyshlennosti i Lesnogo Khozyaistva	All-Union Scientific, Engineering and Technical Society of the Lumber Industry and Forestry
Zap. Bot. sada SPb. univ.	Zapiski Botanicheskogo sada Sankt-Peterburgskogo universiteta	Reports of the Botanical Garden of the St. Petersburg University
Zashch. rast.	Zashchita rastenii	Plant Protection
Zashch. rast. ot. vredit. i boleznei	Zashchita rastenii ot vreditelei i boleznei	Plant Protection against Pests and Diseases
Zhurn. Novocherk. otd. Russk. bot. obshch.	Zhurnal Novocherkasskogo otdeleniya Russkogo botanicheskogo obshchestva	Journal of the Novocherkassk Branch of the Russian Botanical Society